



Project No. 60251

Volume 3 of 3
Quality Assurance Project Plan
Appendices G-O
Remedial Investigation/Feasibility Study
American Chemical Services, Inc.
Griffith, Indiana

Prepared for:
American Chemical Services
Steering Committee
Chicago, Illinois

Prepared by:
Warzyn Engineering Inc.
Chicago, Illinois

May 1989

APPENDIX G

FIELD MEASUREMENT OF pH

FIELD MEASUREMENT OF pH

Method: Electrometric

Reference: EPA 1979, Page 150.1

Sensitivity: 0.1 pH unit

Optimum Range: 1-12 pH units

Sample Handling: Determine on-site or within 6 hours.

Reagents and Apparatus:

1. pH meter (Orion Model 211 Mini pH meter).
2. Combination electrodes
3. Beakers or plastic cups.
4. pH buffer solutions, pH 4, 7, and 10.
5. Deionized water in squirt bottle.
6. All glassware soap and water washed, followed by two hot water rinses and two deionized water rinses.

Calibration:

1. Place electrode in pH7 buffer solution.
2. After allowing several minutes for meter to stabilize, turn calibration dial until a reading of 7.00 is obtained.
3. Rinse electrode with deionized water and place in pH4 or pH10 buffer solution.
4. Wait several minutes and then turn slope adjustment dial until a reading of 4.00 or 10.00 is obtained.
5. Rinse electrode with deionized water and place in pH7 buffer. If meter reading is not 7.00, follow Steps 2-5 again.

Procedure:

1. Calibrate meter using calibration procedure.
2. Pour the sample into a clean beaker or plastic cup.

3. Rinse electrode with deionized water between samples. Recheck calibration with pH7 buffer solution after every 5 samples.
4. Immerse electrode in solution allowing several minutes for meter to stabilize. Make sure the white KCl junction on side of electrode is in the solution. The level of electrode solution should be one inch above sample to be measured.

Notes:

1. When calibrating the meter, use pH buffers 7 and 4 for samples with pH < 8, and buffers 7 and 10 for samples with pH > 8. If meter will not read pH4 or 10, something may be wrong with the electrode. Return it to the lab with a note.
2. pH is a temperature dependent analysis. Therefore, temperatures of buffers and samples should be within about 2°C. For refrigerated or cool samples, use refrigerated buffers to calibrate meter.
3. Weak organic and inorganic salts and oil and grease are interferences in pH measurements. If oil and grease are visible, note on data sheet. Clean electrode with soap and water, followed by 10% HCl. Then recalibrate meter.
4. When not in use, the electrode should be stored in pH4 buffer.
5. Before going into the field:
 - a) Check batteries;
 - b) Do a quick calibration at pH7 and 4 to check electrode;
 - c) Obtain fresh solutions.
6. Following field measurements:
 - a) Report any problems;
 - b) Compare with previous data;
 - c) Clean all dirt off of meter and inside case;
 - d) Make sure electrode is stored in pH4 buffer.

(Page 1 of 7)

INSTRUCTION MANUAL
model 211
digital pH meter

ORION RESEARCH

contents

introduction	3
instrument description	3
Instrument set-up	4
support rod	
power source	
meter check-out	
connecting electrodes	
measurement procedures	6
general measurement technique	
pH measurement	
single-buffer standardization	
two-buffer standardization	
battery replacement	8
recorder output	8
repair and service	8
accessories	9
specifications	10
notice of compliance	11

repair/service

For information on repair or replacement of this instrument, contact Orion Research toll-free. Ask for Customer Service.

ORION RESEARCH INCORPORATED

Customer Service

840 Memorial Drive

Cambridge, Massachusetts 02139 U.S.A.

800-225-1480 (Continental U.S.)

617-864-5400 (Massachusetts, Alaska, Hawaii, Canada)

Telex: 921466

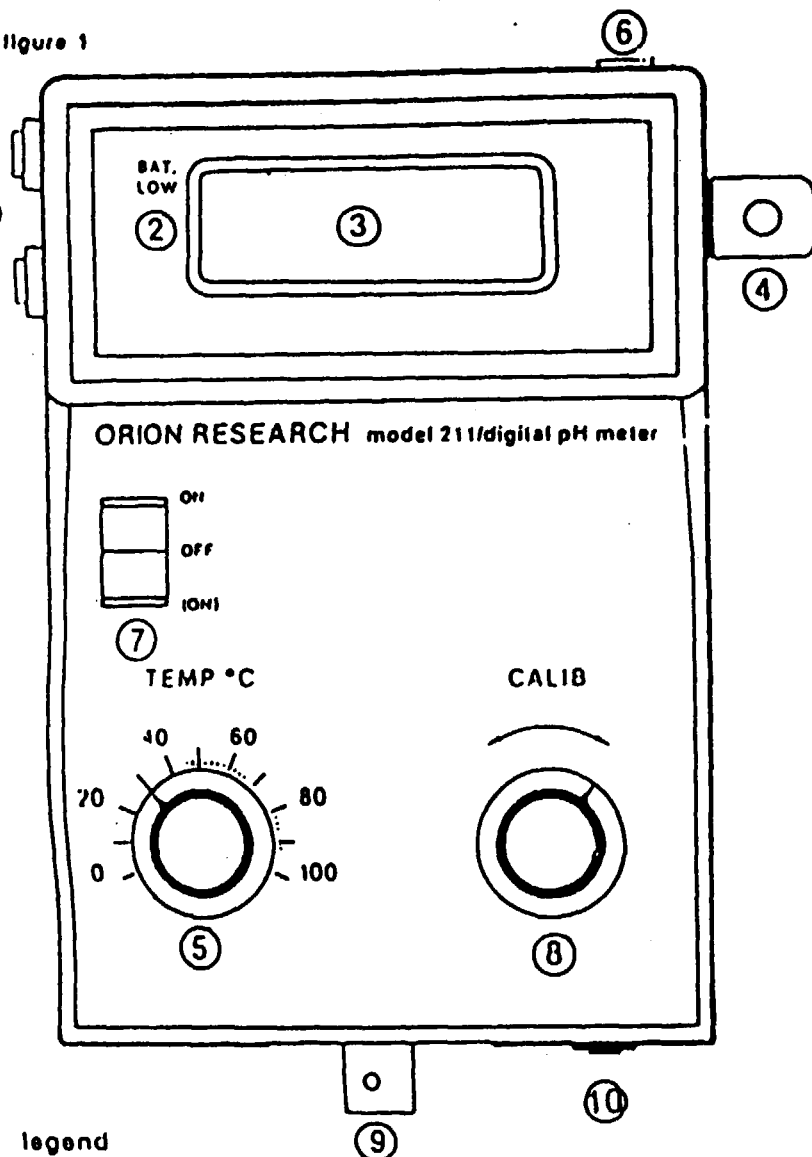
©1983 Orion Research Incorporated

ORION® is a registered trademark of Orion Research Incorporated

Form 161211/3880

Printed in U.S.A.

Figure 1



Legend

- | | |
|---------------------------------------|--------------------------|
| 1. strip chart recorder binding posts | 6. AC line adapter input |
| 2. BAT LOW | 7. function control |
| 3. LC display | 8. calibration control |
| 4. support rod clip | 9. electrode connector |
| 5. temperature indicator control | 10. slope control |

introduction

The Model 211 is a battery- or line-operated (110/220 V AC adapter) digital pH meter for field or laboratory use. The meter is complete with strip chart recorder binding posts and is supplied with an unbreakable, gel-filled combination pH electrode, one packet of pH 7 buffer powder, one bottle for pH 7 buffer, one bottle for distilled water, support rod, electrode holder, AC adapter, six 1.5 V batteries, shorting plug, and carrying case.

instrument description

See Figure 1.

1. strip chart recorder binding posts: black post is low (ground) and red post is high input side of recorder. See page 8.
2. BAT LOW: an arrow pointing towards BAT LOW appears on the display when battery requires replacement.
3. LC display: pH display over the range of 0 - 14 with ± 0.1 pH units resolution.
4. support rod clip: holds steel rod used to mount electrode holder.
5. temperature indicator control (TEMP °C): compensates for variation in electrode slope or temperature changes. Used in two-buffer calibration.
6. AC line adapter input: jack used to insert AC line adapter. With AC line adapter operational, the internal battery is bypassed.
7. function control: rocker switch with three positions - ON, OFF and (ON). Depress (ON) for a momentary reading. The switch will return to OFF when released.
8. calibration control (CALIB): used to calibrate the meter with buffers of known pH.
9. electrode connector: accepts BNC connector from pH electrode.
10. slope control: screwdriver adjustment used to set second buffer in two-buffer calibration.

instrument set-up

support rod

1. Insert steel support rod into the hole in the support rod clip on side of the meter.
2. Mount electrode holder on the rod by pinching to compress the spring. Release to hold in place.

power source

The Model 211 operates on six nonrechargeable 1.5 volt batteries or on 110 or 220 \pm 20% V with an approved AC adapter (specify voltage when ordering). Low battery is indicated by the BAT LOW indicator on the display.

NOTE: Batteries are not rechargeable - use of line adapter whenever possible will prevent the unit's batteries from being discharged. If battery operation is desired, follow installation instructions under battery replacement.

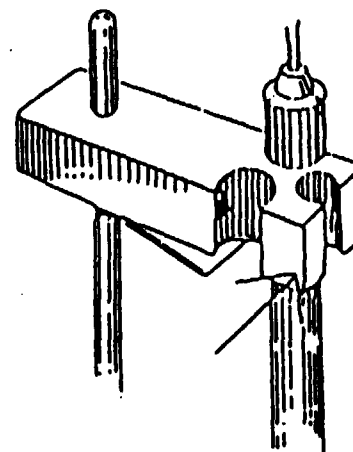
meter check-out

1. Install six AA batteries in the meter. Orient the (+) and (-) battery terminals to match the orientation shown in the battery compartment.
2. Depress ON button on the front panel. If the BAT. LOW indicator on the front display lights up, the batteries must be replaced.
3. If battery mode is not to be used, disregard steps 1 and 2. Insert pin end of appropriate AC line adapter into the meter, and the other end into the appropriate grounded AC line receptacle.
4. Attach BNC shorting plug to BNC input on the bottom side of the meter. Depress ON button on the front panel. Turn CALIB knob so display reads a steady 7.00. If this cannot be done consult ORION Technical Service.
5. Remove the shorting plug. Successful completion of steps 1-4 show the meter is ready for use.

connecting electrode

1. Insert the BNC connector into the electrode jack on the bottom panel of the meter. Turn connector clockwise until it seals firmly.
2. Mount electrode in the electrode holder by spreading the electrode clip open and sliding the electrode into the holder so that the clip closes on electrode cap. See figure 2.
3. Follow measurement procedures to use the meter to measure pH.
4. Disconnect electrode by turning connector counterclockwise until released from pin.

figure 2



SQUEEZE AS SHOWN TO INSERT ELECTRODE

measurement procedures

General measurement technique

Temperature: All samples and buffers should be at the same temperature, as small variations in temperature can cause errors in measurement. The slope of the pH electrode, the potential of the reference electrode, and the pH of the buffers are temperature-dependent.

Cleaning electrodes: Electrode should be rinsed and shaken between measurements to remove drops and to prevent solution carryover.

Stirring: Stir measured solutions moderately to obtain good contact between the glass bulb and the solution. Insert electrode to a depth of about 3 cm.

4 measurements

Single-buffer standardization
(where maximum precision is not required)

NOTE: For maximum accuracy it is recommended that a two-buffer calibration be performed once at the beginning of each day (see page 7). This procedure ensures the correct setting of the slope control. Subsequent measurements during the day may be made using a single point calibration.

1. Place the electrode in a buffer solution whose pH is near the expected pH of the sample. Insert electrode to a depth of about 3 cm and stir moderately.
2. Set the temperature indicator control to the temperature of the buffer.
3. Set the function control to ON and allow the buffer reading to stabilize. Adjust the CALIB so that the display indicates the pH of the buffer at the solution temperature. See Table 1.
4. Remove the electrode from the buffer solution and rinse by stirring moderately in distilled water. Shake off excess drops of water.
5. Place electrode in the sample to a depth of about 3 cm and stir moderately. Set the function control to ON and allow the reading to stabilize. Record the steady pH reading.

Two-buffer standardization
(where maximum precision is required)

1. Select two buffers to bracket the expected pH of the sample, with one buffer having a pH of 7.
2. Place the electrode in the pH 7 buffer to a depth of about 3 cm and stir moderately. Set the temperature indicator control to the temperature of the buffer. Set the function control to ON and allow the reading to stabilize. Turn CALIB until the display indicates the pH of the buffer at the solution temperature. See Table 1.
3. Remove electrode from the first buffer and rinse by stirring moderately in distilled water. Shake off excess drops of water.
4. Place the electrode in the second buffer to a depth of about 3 cm and stir moderately. Set the function control to ON and adjust the slope control until the pH at the solution temperature is displayed. See Table 1.
5. Remove the electrode and rinse by stirring moderately in distilled water. Shake off excess drops of water.
6. Place the electrode in the sample to a depth of about 3 cm and stir moderately. Set the function control to ON and allow the reading to stabilize. Record the steady pH reading.

TABLE 1

TEMP (°C)	pH 7.00 Buffer	pH 4.01 Buffer	pH 10.01 Buffer
5	7.08	4.00	10.25
10	7.06	4.00	10.18
15	7.03	4.00	10.12
20	7.01	4.00	10.06
25	7.00	4.01	10.01
30	6.98	4.02	9.97
35	6.98	4.02	9.93
40	6.97	4.03	9.89
50	6.97	4.06	9.83
60	6.98	4.09	--

battery replacement

To replace the batteries, remove the panel on the back of the meter. Be sure to observe the polarity marking when inserting new batteries.

recorder output

The red and black binding posts at the side of the meter provide an output for strip chart recording of absolute mV independent of function mode. For recorders with input impedance of 100 Kilohms or greater, the output is fixed to about 100 mV/pH. pH 14.00 output is 1.40 V. Lower impedance recorders may be used but full-scale output is reduced.

1. Connect the lead from the high (input side of the recorder) to the red binding post and the lead from the low (ground) side to the black binding post.
2. Proceed according to directions in the strip chart recorder instruction manual.

repair and service

ORION warranty covers failures due to manufacturer's workmanship or material defect from the date of purchase by the user. User should return the warranty card to ORION and retain proof of purchase. Warranty is void if product has been abused, misused, or repairs attempted by unauthorized persons.

Warranties herein are for products sold/installed for use only in the United States and Canada. For ORION products purchased for use in all other countries consult local in-country, authorized ORION sales agent/distributor for product warranty information.

Return Authorization Number must be obtained from ORION Laboratory Products Customer Service before returning any product for in-warranty repair, replacement or credit.

"No Lemon" Instrument Warranty

The instrument is covered by the ORION "No Lemon" warranty. If the instrument fails within twelve months from date of purchase for any reason other than abuse, the purchaser may elect to have it repaired or replaced at no charge. This warranty covers the original or replacement/repaired meter from date of original meter purchase; the warranty is not extended beyond the buyer's original warranty date.

accessories

815600	Ross™ epoxy body, bulb guard combination pH electrode
9104BN	Laboratory grade combination pH electrode (BNC connector)
910600	GX-series epoxy body, gel-filled combination electrode (BNC connector)
912600	GX-series epoxy body, gel-filled flask combination electrode (BNC connector)
913600	GX-series epoxy body, gel-filled flat surface combination pH electrode (BNC connector)
915600	RX-series refillable, epoxy body combination pH electrode (BNC connector)
9162BN	Combination pH electrode with rugged bulb (BNC connector)
9163BN	Combination pH electrode with needle shape (BNC connector)
910004	pH 4 buffer packets, box of 25 packets, each packet making 200 ml of buffer
910007	pH 7 buffer packets, box of 25 packets, each packet making 200 ml of buffer
910009	pH 9 buffer packets, box of 25 packets, each packet making 200 ml of buffer
910104	pH 4.01 buffer, 475 ml bottle
910107	pH 7.00 buffer, 475 ml bottle
910110	pH 10.01 buffer, 475 ml bottle
970899	Dissolved oxygen electrode
910002	Electrode holder
020030	Shorting plug
020120	110V AC line adapter
020121	220V AC line adapter

specifications

package contents	model 211 digital pH meter, with model 910600 gel-filled unbreakable combination pH electrode, support rod, electrode holder, bottles for pH 7 buffer and distilled water, one packet pH 7 buffer powder, AC adapter, six 1.5 V batteries, and carrying case
range	0 to 14 pH
resolution	$\pm .01$ pH
temperature compensation	manual (0 to 100°C)
isopotential point	pH 7 (fixed)
power requirement	six 1.5 V batteries; battery life: 3000 ten second intermittent measurements when line adapter is not used. line adapter: 110 or 220 V $\pm 20\%$, 50/60 Hz
dimensions	14 cm high x 9 cm wide x 4.5 cm deep
weight	0.4 kg

specifications subject to change without notice

notice of compliance

The Model 211 may generate radio frequency energy and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class B computing device in accordance with specifications in Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If the Model 211 does cause interference to radio or television reception, which can be determined by turning the unit off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- reorient the receiving antenna
- relocate the Model 211 with respect to the receiver
- move the Model 211 away from the receiver
- plug the Model 211 into a different outlet so that the meter and receiver are on different branch circuits

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet prepared by the Federal Communications Commission helpful:

"How to Identify and Resolve Radio-TV Interference Problems"

This booklet is available from the U.S. Government Printing Office, Washington, DC 20402, Stock No. 004-000-00345-4.

APPENDIX H

**FIELD MEASUREMENT OF
SPECIFIC CONDUCTANCE AND TEMPERATURE**

FIELD MEASUREMENT OF SPECIFIC CONDUCTANCE
AND TEMPERATURE

Method: Specific Conductance, umhos @ 25°C

Reference: EPA 1979, Page 120.1, Standard Methods, 15th edition, pp 70-73

Detection Limit: 1 umho/cm @ 25°C

Optimum Range: 0.1 - 100,000 umhos/cm

Sample Handling: Determine on-site or within 24 hours

Reagents and Apparatus:

1. Conductivity meter (YSI) and electrodes.
2. Deionized water in squirt bottle.
3. Standard potassium chloride solution, 0.0100 N.

Procedure:

YSI Conductivity Meter

1. With mode switch at off position, check meter zero. If not zeroed, use meter screw and adjust to zero.
2. Plug probe into jack on side of meter.
3. Turn mode switch to red line, and turn red line knob until needle aligns with red line on dial. Change batteries if cannot be aligned.
4. Totally immerse probe in sample. Do not allow the probe to touch the sample container.
5. Turn mode switch to appropriate conductivity scale, X100, X10, or X1. Use a scale that will give a mid-range output on the meter.
6. Wait for needle to stabilize (about 15 sec.) and record conductivity multiplying by scale setting.
7. While gently agitating the probe, take sample temperature (°C) and record.
8. Rinse probe with deionized water.
9. Record specific conductivity (1st column) and temperature on F.O.S. sheet.

Notes:

1. Calculate conductivity using following formula:

$$G_{25} = \frac{G_T}{[1 + 0.02 (T-25)]}$$

G_{25} = Conductivity at 25°C, umhos/cm

T = Temperature of sample, °C

G_T = Conductivity of sample at temperature T , umhos/cm

2. Report results for the standard solution with each data set.
3. Record on field sheet which meter and probe were used. Meter should be wiped clean as necessary.
4. After returning to lab, compare results with previous data. Report problems to lab personnel.

Reagent Preparation:

1. Stock Potassium Chloride Solution, 1.00 N: Dissolve 74.555 g. KCl in Milli-Q water and dilute to 1,000 ml. in a volumetric flask.
2. Standard Potassium Chloride Solution, 0.0100N: Dilute to 10.0 mls. of stock solution to 1,000 mls. with Milli-Q water using a volumetric pipet and flask.

TABLE OF CONTENTS

	Page
GENERAL DESCRIPTION	2
SPECIFICATIONS	2
OPERATION PROCEDURE	4
1 Setup	4
2 Temperature	5
3 Salinity	5
4 Conductance	5
5 Error	6
CIRCUIT DESCRIPTION MAINTENANCE AND CALIBRATION	9
1 Description	9
2 Maintenance	9
3 Calibration	9
PROBE	12
1 Description of YSI 3300 Conductivity/Temperature Probe	12
2 Maintenance	12
3 Probe Use	14
4 Cell Calibration & Standard Solutions	14
YSI MODEL 33 AND 33M USED WITH YSI 51A 54 AND 57 OXYGEN METERS	16
WARRANTY	21

GENERAL DESCRIPTION

The YSI Model 33 and 33M S-C-T Meters are portable, battery powered, transistorized instruments designed to accurately measure salinity, conductivity and temperature. They use a probe consisting of a rugged, plastic conductivity cell and a precision YSI thermistor temperature sensor combined in a single unit.

Conductivity with the Model 33 is expressed as micromhos/centimeter ($\mu\text{mhos/cm}$); with the 33M, it's millisiemens/meter (mS/m). These are measurements of the electrical conductance the sample would show if measured between opposite faces of a 1cm cube. (Conversion information: 1 $\mu\text{mho/cm}$ = 0.1 mS/m.) Salinity is the number of grams of salt/kilogram of sample (‰ = parts per thousand). This measurement assumes the sample contains a "standard" sea water salt mixture. The sample temperature is measured in degrees Celsius.

Salinity measurements are manually temperature compensated by direct dial. Conductivity measurements are not temperature compensated, however, a temperature function is provided on the instrument to aid with calculation of corrections. Also, when just temperature and conductivity are known it is possible to calculate salinity and when only temperature and salinity are known it is possible to calculate conductivity.

SPECIFICATIONS

Model 33 Conductivity

Ranges	0-500, 0-5,000, 0-50,000 $\mu\text{mhos/cm}$ with YSI 3300 Series Probes (Note: The "μmho" designations on the meter are a shorthand form for "μmho/cm".)
Accuracy	+2.5% max error at 500, 5,000 and 50,000 plus probe +3.0% max error at 250, 2,500 and 25,000 plus probe See Error Section

2

Readability	2.5 $\mu\text{mhos/cm}$ on 500 $\mu\text{mho/cm}$ range 25 $\mu\text{mhos/cm}$ on 5,000 $\mu\text{mho/cm}$ range 250 $\mu\text{mhos/cm}$ on 50,000 $\mu\text{mho/cm}$ range
-------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Temperature Compensation None

Model 33M Conductivity

Ranges	0-50, 0-500, 0-5,000 mS/m with YSI 3300 Series Probes
Accuracy	±2.5% max error at 50, 500 and 5,000 plus probe ±3.0% max error at 25, 250 and 2,500 plus probe See Error Section
Readability	0.25 mS/m on 50 mS/m range 2.5 mS/m on 500 mS/m range 25.0 mS/m on 5,000 mS/m range
Temperature Compensation	None

Salinity

Range	0-40 ‰ in temperature range of 2 to 14.5°C
Accuracy	Above 4°C: ±0.9 ‰ at 40 ‰ and ±0.7 ‰ at 20 ‰ plus conductivity probe Below 4°C: ±1.1 ‰ at 40 ‰ and ±0.9 ‰ at 20 ‰ plus conductivity probe See Error Section
Readability	0.2 ‰ on 0-40 ‰ range
Temperature Compensation	Manual by direct dial from 2 to 14.5°C

3

Temperature Range	-2 to 150°C
Accuracy	±0.1°C at -2°C, ±0.6°C at 45°C plus probe See Error Section
Readability	±0.15°C at -2°C to ±0.37°C at 45°C
Power Supply	Two D-size alkaline batteries. Eveready E95 or equivalent provide approximately 200 hrs. of operation
Probe	YSI 3300 Series Conductivity/Temperature Probe Nominal Probe Constant $K = 5/\text{cm}$
Accuracy	±2% of reading for conductivity and salinity Error of ±0.1°C at 0°C and 1.03°C at 40°C
Instrument Ambient Range	Satisfactory operation -5 to 145°C A maximum error of ±0.1% of the reading per °C change in instrument temperature can occur. This error is negligible if the instrument is readjusted to redline for each reading.

OPERATION PROCEDURE

1. Setup

- Adjust meter zero (if necessary) by turning the bakelite screw on the meter face so that the meter needle coincides with the zero on the conductivity scale.
- Calibrate the meter by turning the MODE control to REDLINE and adjusting the REDLINE control so the meter

needle lines up with the redline on the meter face. If this cannot be accomplished, replace the batteries.

- Plug the probe into the probe jack on the side of the instrument.
- Put the probe in the solution to be measured. (See Probe Use.)

2. Temperature

Set the MODE control to TEMPERATURE. Read the temperature on the bottom scale of the meter in degrees Celsius. Allow time for the probe temperature to come to equilibrium with that of the water before reading.

3. Salinity

- Transfer the temperature reading from Step 2 to the °C scale on the instrument.
- Switch the MODE control to the SALINITY position and read salinity on the red 0-40‰ meter range.
- Depress the CELL TEST button. The meter reading should fall less than 2% if greater, the probe is fouled and the measurement is in error. Clean the probe and re-measure.

4. Conductivity on Model 33 (Model 33M data are in parentheses.)

- Switch the MODE control to the X100 scale. If the reading is below 50 on the 0-500 range (50 on the 0-50 range), switch to the X10 scale. If the reading is still below 50 (50), switch to the X1 scale. Read the meter scale and multiply the reading appropriately. The answer is expressed in $\mu\text{mhos/cm}$ (mS/m). Measurements are not temperature compensated.

Example: Meter Reading 247 (24.7)

Scale X10

Answer 2470 $\mu\text{mhos/cm}$
(247.0 mS/m)

(b) When measuring on the X100 and X10 scales, depress the CELL TEST button. The meter reading should fall less than 2%. If greater, the probe is fouled and the measurement is in error. Clean the probe and re-measure.
NOTE: The CELL TEST does not function on the X1 scale.

5. Error

The maximum error in a reading can be calculated by using the graphs in the following sections.

(1) Temperature

The temperature scale is designed to give the minimum salinity error when the temperature readings are used to compensate salinity measurements.

Figure 1 shows total error for probe and instrument versus °C meter reading.

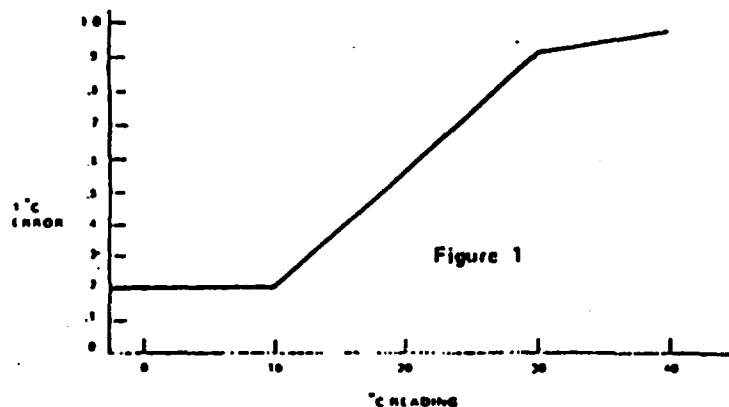


Figure 1

Example: Meter Reading 15°C
Total Error 0.4°C
Accuracy 15°C ± 0.4°C for probe and instrument combined

(2) Conductivity on Model 33 (Model 33M data are in parentheses)

Figure 2 shows the worst-case conductivity error as a function of the conductivity reading for the probe and instrument combined.

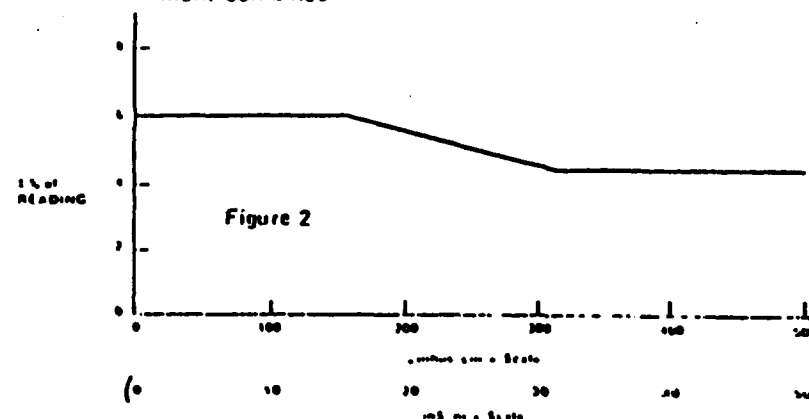
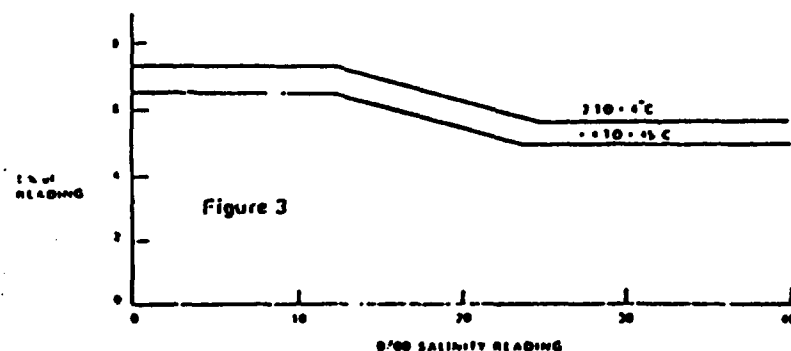


Figure 2

Example: Meter Reading 360 μmhos/cm (36 mS/m)
Scale X10
% Reading Error ± 4.5%
Accuracy 3600 ± 162 μmhos/cm (360 ± 16.2 mS/m) for probe and instrument

(3) Salinity

The salinity readings are a function of temperature and conductivity, therefore the accuracy is a function of both. The temperature scale and temperature control have been designed to minimize the temperature error contribution to the salinity error. The error shown in Figure 3 is the total of the temperature and conductivity probe, the temperature scale and the salinity scale error.



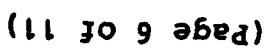
Example: Meter Reading. 100/00. @ 10°C

% of
Reading
Error.

6.5%

Accuracy:

10.4% ± 0.65% for all
errors, combined worst
case.



CIRCUIT DESCRIPTION, MAINTENANCE AND CALIBRATION

1. Description

The circuit is composed of two parts, a multivibrator and switching transistors. The multivibrator produces a square waveform voltage. The square wave is applied to two switching transistors. They alternately apply two batteries of opposite polarity to the probe thus providing AC power which minimizes polarization effects. The meter is in series with one battery and measures the current from it. The current from the battery is proportional to the conductance of the cell. Salinity is measured in a special range conductivity circuit which includes a user-adjusted temperature compensator. In the temperature, redline and X1 positions the multivibrator operates at 100 Hz. In the salinity, X100 and X10 positions the multivibrator operates at 600 Hz and in these ranges pushing the CELL TEST button drops the frequency to 100 Hz allowing the operator to judge the degree of probe polarization.

2. Maintenance

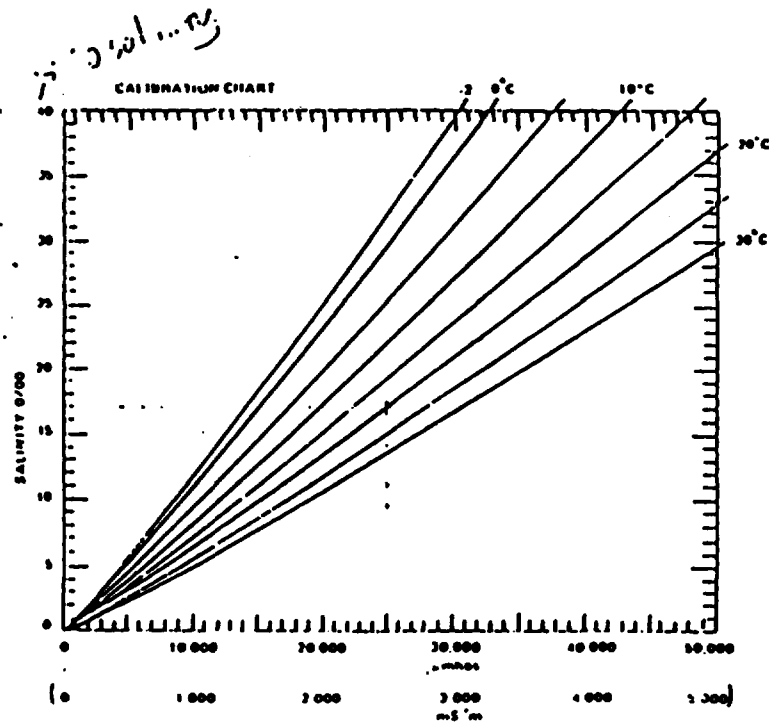
The only maintenance required is battery replacement. Two "D" size alkaline flashlight cells, such as Eveready E95 or equivalent, will provide 200 hrs. of operation. Accuracy will not be maintained if zinc-carbon "D" cells are used. Battery replacement is indicated when the redline adjustment cannot be accomplished.

Replace batteries every six months to reduce the danger of corrosion due to leaky batteries. To replace batteries, remove the six screws from the rear plate. The battery holders are color coded. The Positive (+ button) end must go on red.

3. Calibration of Model 33 (Model 33M data are in parentheses)

It is possible for the temperature knob to become loose or slip from its normal position. In an emergency the dial can be re-positioned. It must be emphasized that this is an emergency procedure only, and that the instrument should be returned to the factory for proper recalibration at the earliest opportunity.

- (a) Read the temperature and conductivity of the solution. Determine the salinity of the solution by running a line vertically on the graph from this conductance value until it intersects the appropriate °C line (interpolate as required for temperature between the given °C lines). From this intersection extend a



line horizontally to the edge of the graph. This determines the salinity for this sample.

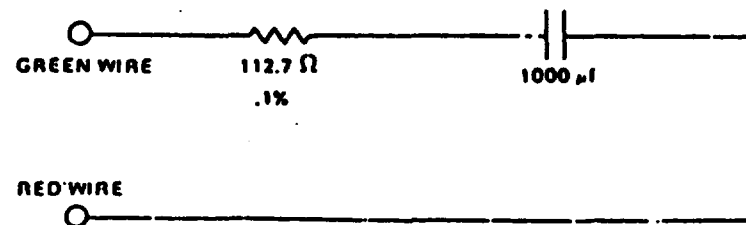
Example: 25,000 $\mu\text{mhos/cm}$ and 20°C gives a salinity of 17
 (Example: 2,500 mS/m and 20°C gives a salinity of 17)

- (b) Remove the °C knob, switch to SALINITY, and turn the control shaft until the meter needle indicates the salinity value determined in Step (a). In the example given, the value is 17.
- (c) Switch to TEMPERATURE (Note: This temperature reading must be the same as Step (a), if not, begin again at Step (a)). Place the knob on the control shaft (without turning the control shaft) with the knob pointer at the same temperature as the meter reading and tighten both set screws securely.

At earliest opportunity recalibrate using the following procedure or return the instrument to factory for service:

- (a) Set the instrument for a salinity measurement as normal.
 (b) Substitute a 1000 μf capacitor and 112.7 ohm 0.1% tolerance resistor for the probe.

Connect the resistor and capacitor between the green wire and red wire on the jack connections inside the instrument.



(c) Turn the temperature dial until the meter reads redline. Now install the temperature knob with the arrow at 25°C. This is a temporary calibration only. Return the instrument to the factory for proper recalibration.

PROBE

1 Description of YSI 3300 Series Conductivity/Temperature Probe

The YSI 3300 Series Conductivity Probes are designed for field use, embodying construction and design for rugged, accurate service. Each probe features a built-in cell constant of 50 (500 O/M) $\pm 2\%$, a precision YSI thermistor temperature sensor of $\pm 0.1^\circ\text{C}$ accuracy at 0°C and $\pm 0.3^\circ\text{C}$ at 40°C and a low capacitance cable assembly terminating in a three terminal 0.25" dia. phone type connector.

The 3310 has a 10 ft cable and the 3311 is a 50 ft version. Other lengths are available on special order.

The probe has a rigid P.V.C. body, platinumized pure nickel electrodes, and a durable cable providing resistance to a wide range of water-borne substances.

2 Maintenance

(a) Cleaning

When the cell test indicates low readings the probable cause is dirty electrodes. Hard water deposits, oils and organic matter are the most likely contaminants.

For convenient normal cleaning soak the electrodes for 5 minutes with a locally available bathroom tile cleaning preparation such as: Down Chemical Bathroom Cleaner, Hazen Industries Rally Tile, Porcelain and Chrome Cleaner, Johnson Wax Emu Instant Cleaner, or Lysol Brand Basin Tub Tile Cleaner.

For stronger cleaning a 5 minute soak in a solution made of 10 parts distilled water, 10 parts isopropyl alcohol and 1 part HCl can be used.

Always rinse the probe after cleaning and before storage.

CAUTION: Do not touch the electrodes inside the probe. Platinum black is soft and can be scraped off.

If cleaning does not restore the probe performance, re-platinizing is required.

(b) Re-Platinizing

Equipment Required —

- (1) YSI #3140 Platinizing Solution, 2 fl. oz. (3% platinum chloride dissolved in 0.025% lead acetate solution)
- (2) YSI Model 33 or 33M S-C-T Meter
- (3) 50 ml glass beaker or equivalent bottle
- (4) Distilled water

Procedure —

- (1) Clean the probe as in Section (a) either method.
- (2) Place the cell in the beaker and add sufficient YSI #3140 solution to cover the electrodes. Do not cover the top of the probe.
- (3) Plug the probe into the Model 33 or 33M, switch to the X100 scale to platinize the electrode. Move the probe slightly to obtain the highest meter reading and continue platinizing for the approximate time shown below.

Meter Reading		Time
$\mu\text{mhos/cm}$	mS/m	(minutes)
30,000	3,000	5
25,000	2,500	6
20,000	2,000	8
15,000	1,500	11
10,000	1,000	16

(4) After the elapsed time remove the probe and rinse in fresh water.

(5) Return the solution to its container. 2 oz. of solution should be sufficient for 50 treatments.

3. Probe Use

(a) Obstructions near the probe can disturb readings. At least two inches of clearance must be allowed from non-metallic underwater objects. Metallic objects such as piers or weights should be kept at least 6 inches from the probe.

(b) Weights are attached to the cable of the YSI 3310 and 3311 Probes. The YSI 3327 Weights are supplied in pairs with a total weight of 4 ounces per pair. Should it become necessary to add more weight to overcome water currents, we suggest limiting the total weight to two pounds (8 pairs). For weights in excess of two pounds use an independent suspension cable. In either case, weights must be kept at least 6 inches away from the probe.

(c) Gentle agitation by raising and lowering the probe several times during a measurement insures flow of specimen solution through the probe and improves the time response of the temperature sensor.

4. Cell Calibration & Standard Solutions

The YSI 3300 Series Cells are calibrated to absolute accuracy of $\pm 1.5\%$ based on a standard solution. Since the literature on conductivity does not indicate a consistently accepted standardization method we have chosen the 0.01 normal KCl solution method as determined by Jones and Bradshaw in 1937 as our standard. Recent textbooks, as well as the ASTM standards, concur with this choice.

The solution is prepared by diluting 0.745 grams of pure dry KCl with distilled water until the solution is 1 kilogram. The table below shows the values of conductivity this solution would have if the distilled water were non-conductive. However, since even high purity distilled

water is slightly conductive, the measured conductivity will be higher by an amount equal to the water's conductivity.

Temperature °C	Conductivity	
	$\mu\text{mhos/cm}$	mS/m
15	1141.5	114.2
16	1167.5	116.8
17	1193.6	119.4
18	1219.9	122.0
19	1246.4	124.6
20	1273.0	127.3
21	1299.7	130.0
22	1326.6	132.7
23	1353.6	135.4
24	1380.8	138.1
25	1408.1	140.8
26	1436.5	143.7
27	1463.2	146.3
28	1490.9	149.1
29	1518.7	151.9
30	1546.7	154.7

The operator may use the standard solution and the table to check the accuracy of a cell's constant or to determine an unknown constant. The formula is shown below:

$$K = \frac{R(C_1 + C_2)}{10^6} \quad \text{or} \quad \frac{R(S_1 + S_2)}{10^6}$$

where: K = Cell constant
 R = Measured resistance in Ω
 C₁ = Conductivity in $\mu\text{mhos/cm}$
 C₂ = Conductivity in $\mu\text{mhos/cm}$ of the distilled water used to make solution

S_1 = Conductivity in mS/m
 S_2 = Conductivity in mS/m of the distilled water used to make the solution.

n , C_1 and C_2 , or S_1 and S_2 , must either be determined at the same temperature or corrected to the same temperature to make the equation valid

Note: For further information on conductivity and the above standard information, refer to ASTM Standards Part 23 -- Standard Methods of Test for Electrical Conductivity, or Water and Industrial Waste Water -- ASTM Designation D1125 64

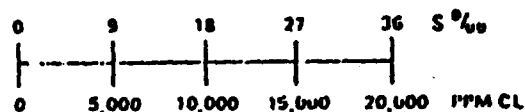
YSI MODEL 33 AND 33M USED WITH YSI 51A, 54 and 57 OXYGEN METERS

If the salinity measurement is to be used for salinity correction on the 51A, the reading should be converted to Chlorosity. The formula is

$$\text{PPM Chlorosity} = \frac{\text{Salinity } \%_{\text{me}} \cdot 0.03}{1.8} \times 10^3$$

For these instruments the 0.03 can be neglected so the equation simplifies to

$$\text{PPM Cl} = \frac{\text{SS } \%_{\text{me}} \times 10^3}{1.8}$$



For salinity correction when using the Model 57 use the salinity reading direct from the Model 33 or 33M. No conversion is necessary.

Model 33 and 33M salinity readings taken in conjunction with Model 54 dissolved oxygen readings can be used to correct the Model 54 for salinity and to make post-measurement salinity corrections to dissolved oxygen data. Correction tables are available from the factory.

WARRANTY

All YSI products carry a one-year unconditional warranty on workmanship and parts, exclusive of batteries. Damage through accident, misuse, or tampering will be repaired at a nominal charge.

If you are experiencing difficulty with any YSI product, it may be returned to an authorized YSI dealer for repair, even if the warranty has expired. If you need factory assistance for any reason, contact

Service Department
 Yellow Springs Instrument Co., Inc.
 P.O. Box 279
 Yellow Springs, Ohio U.S.A.
 Phone (513) 767-7241

APPENDIX I

CALIBRATION AND MAINTENANCE OF HNU PHOTOIONIZER

TABLE OF CONTENTS

- I. INSTRUCTION**
 - 1.0 OPERATION PRINCIPLE**
 - 2.0 INSTRUMENT SENSITIVITY AND CALIBRATION**
 - 3.0 INSTRUMENT SPECIFICATIONS**
- II. OPERATIONAL PROCEDURE**
 - 1.0 INSTRUMENT CHECKOUT**
 - 2.0 FIELD OPERATION**
 - 2.1 CALIBRATION**
 - 2.1.1 EQUIPMENT AND MATERIALS**
 - 2.1.2 CALIBRATION FREQUENCY**
 - 2.1.3 CALIBRATION PROCEDURE**
 - 2.2 SAMPLE MEASUREMENTS**
- III. MAINTENANCE AND TROUBLE SHOOTING**
 - 1.0 BATTERY RECHARGING**
 - 2.0 GENERAL FAULTS DETERMINATION AND CORRECTION**
 - 3.0 SPECIFIC FAULTS**

OPERATION PROCEDURE FOR
HNU MODEL PI 101
PHOTOIONIZATION ANALYZER

I. INTRODUCTION

1.0 Operation Principle

The HNU Model 101 photoionization detector has been designed to measure the concentration of trace gases in many industrial or plant atmospheres. The instrument has similar capabilities outdoors. The analyzer employs the principle of photoionization for detection. This process is termed photoionization because the absorption of ultraviolet light (a photon) by a molecule leads to ionization via:



where RH = trace gas

h ν = a photon with an energy greater than or equal to an ionization potential of RH.

The sensor consists of a sealed ultraviolet light source that emits photons which are energetic enough to ionize many trace species (particularly organics), but do not ionize the major components of air such as O₂, N₂, CO, CO₂ or H₂O. A chamber adjacent to the ultraviolet light source contains a pair of electrodes. When a positive potential is applied to one electrode, the field created drives any ions, formed by absorption of UV light, to the collector electrode where the current (proportional to concentration) is measured. The useful range of the instrument is from a fraction of a ppm to about 2,000 ppm.

2.0 Instrument Sensitivity and Calibration

The instrument responds to atmospheric compounds with ionization potentials equal to or less than the ionization energy of the UV light source. If a compound in air has an ionization potential greater than the energy source of the lamp, it will not be detected. Table 1 presents organic and inorganic compounds and the light sources that should be used to detect each compound. The instrument is capable of using 1 of the 3 light sources - 9.5, 10.2, and 11.7 ev lamps. In addition, not all compounds respond equally to each light sources and thus they vary in their sensitivity to ionization. As a result of varying sensitivities to photoionization, the response given by the instrument may or may not reflect the actual atmospheric concentration of the compound being

detected. Table 2 represents the relative sensitivities for various gases relative to a 10.2 ev light source. Use this table to determine the approximate response of the instrument to a compound of interest, and to select the appropriate light (lamp) source.

There are two types of operations that are used for calibration. For Type 1 Operation, a non-regulatory (or non-target) compound such as isobutylene is used for calibration. In this case, the instrument reading is reported in terms relative to the calibration compound used for calibration. For the type 2 operation, the target compound or compounds are used for calibration. As a result, the instrument is calibrated to respond directly in ppm by volume of the target compound(s).

3.0 Instrument Specifications

3.1 Performance

- o Range: 0.1 to 2000 ppm
- o Detection Limit: 0.1 ppm
- o Sensitivity (max.): 0 to 2 ppm FSD over 100 division meter scale
- o Repeatability: $\pm 1\%$ of FSD
- o Linear Range: 0.1 to 600 ppm
- o Useful Range: 0.1 to 2000 ppm
- o Response Time: less than 3 seconds to reach 90% full scale
- o Ambient humidity: up to 95% relative humidity
- o Operating Temperature: Ambient to 40°C
(instrument is temperature compensated so that a 20°C change in temperature corresponds to a change in reading of $\pm 2\%$ full scale at maximum sensitivity).

3.2 Power Requirements and Operating Times

- o Continuous use on battery: approximately 10 hours
- o Continuous use with HNu recorder reduces instrument battery operating time to approximately 5 hours

o Recharge time: less than 14 hours; a 3 hours charge will charge up to 90% full charge

o Recharge Current: maximum 0.4 amps at 15 VDC

II. OPERATIONAL PROCEDURE

1.0 Instrument Check-Out

1.1 Remove instrument box cover by pulling up on fasteners.

1.2 On the instrument panel, there will be a label containing information on light source, calibration date, calibration gas, and span setting.

1.2.1 If the instrument has not been calibrated in the last 14 days or since its last field use, it should be recalibrated. Check the instrument log, which should be maintained with the instrument, for the instrument status and its calibration history. For general use, the instrument should be calibrated to isobutylene at a span setting of 9.8.

1.2.2 Check the label for light source and refer to Table 1 for ionization potentials of various compounds. If the compound you wish to detect is not listed for the light sources provided with instrument, then the light source will have to be changed. Use the probe with the proper light source for the compounds to be detected.

1.2.3 Once it has been determined that the instrument has the correct lamp, the instrument may need to be recalibrated for the specific compound of interest. Use Procedure under 2.1.3 of this Section to calibrate the instrument.

1.2.4 Check the battery supply by connecting the probe to the instrument box, and turning the function switch to the battery check position (Figure 1). (Note: The battery check indicator will not function unless the probe is attached.) The meter needle should deflect to the far right or above the green zone. If the needle is below or just within the green zone or the red LED indicator is on, the battery should be recharged. Follow

the procedure described in Section III (Maintenance and Trouble shooting) to recharge the battery.

1.2.5 Repack the instrument for shipment to the field.

2.0 Field Operation

2.1 Calibration

2.1.1 Equipment and Materials

o Calibration Gas (2 ranges)

Low range 0-20 ppm and mid-range 20-200 ppm of isobutylene gas are used for standard field operation when contaminants are unknown or a mixture of gases is present. The isobutylene gas is used for general calibration because of the instrument's relatively high sensitivity to it and the non-toxic nature of the gas. Note: A specialty gas may be required if a single atmospheric contaminant is present and the contaminant has a sensitivity different from that of the calibration gas (isobutylene).

o Tubing and fittings (see Figure 1).

o Rotometer or bubble flow meter.

o Field Log, calibration form, and data reporting form.

o Table 1 for ionization potentials for compounds of interest.

2.1.2 Calibration Frequency

This instrument should be calibrated after each field use and prior to each field use. Continuous calibration check should be performed frequently during field operation (for example, check the instrument zero and calibration after every 10 measurements) and document the results properly. Caution: Do Not Change the Settings.

2.1.3 Calibration Procedure

2.1.3.1 Use a three-points procedure to facilitate the proper instrument calibration over appropriate operating ranges. Distinct mixtures of calibration gas with known concentration for selective operating range should be used for calibration. Each mixture should give a 3/4 scale deflection in its respective operating range.

2.1.3.2 Instrument Setup.

Step 1: Remove Instrument cover by pulling up on the side straps.

Step 2: Prior to calibration, check the function switch (Figure 2) on the control panel to make sure it is in the OFF position. The probe nozzle is stored inside the instrument cover. Remove cover plate by pulling up on the pins that fasten the cover plate.

Step 3: Remove the nozzle from the cover. Assemble probe by screwing nozzle into casing.

Step 4: Attach probe cable to instrument box inserting 12 pin interface connector of the probe cable into the connector on the instrument panel. Match the alignment keys and insert connector. Turn connector in clockwise direction until a distinct snap and lock is felt.

Step 5: Turn the function switch to the Battery Check position. When the battery is charged, the needle should read within or above the green battery arc on the scale plate. If the needle is below the green arc or the red LED light comes on, the instrument should be recharged prior to making any measurements. Implement steps in Section III to recharge battery.

Step 6: Turn the function switch to the ON position. In this position, the UV

light source should be on. To verify, gaze at the end of the probe for a purple glow. Do Not Look Directly at the Lamp Itself. If the lamp does not come on refer to Maintenance Step in 2.2 (Section III).

Step 7: To zero the instrument, turn the function switch to the standby position and rotate the zero potentiometer until the meter reads zero. Clockwise rotation of the zero potentiometer produces an upscale deflection while counter clockwise rotation yields a downscale deflection. (Note: No zero gas is needed since this is an electronic zero adjustment.) If the span adjustment is changed during instrument calibration, the zero should be rechecked and adjusted. If necessary, wait 15 to 20 seconds to ensure that the zero reading is stable. Readjust as necessary.

2.1.3.3 Calibration Steps

Step 1: Insert one end of T tube (Figure 1) into probe. Insert second end of probe into calibration gas in the 20-200 ppm range. The third end of probe should have the rotometer (bubble meter) attached.

Step 2: Set the function switch in the 0-200 ppm range. Crack the valve on the pressured calibration gas container until a slight flow is indicated on the rotometer. The instrument will draw in the volume required for detection with the rotometer indicating excess flow.

Step 3: Adjust the span potentiometer so that the instrument is reading the exact value of the calibration gas. (Calibration gas value is labeled on the cylinder).

Step 4: Turn instrument switch to the standby position and check the electronic zero. Reset zero

potentiometer as necessary
following step 7 of 2.1.3.2.

- Step 5:** Record on form and field log all original and readjusted settings as specified in the form.
- Step 6:** Next, set the function switch to the 0-20 ppm. Remove the mid-range (20-200 ppm) calibration gas cylinder and attach the low range (0-20 ppm) calibration gas cylinder as described above.
- Step 7:** Do not adjust the span potentiometer. The observed reading should be ± 3 ppm of the concentration specified for the low range calibration gas. If this is not the case, recalibrate the mid range scale repeating Step 1 thru 6 above. If the low range reading consistently falls outside the recommended tolerance range, the probe light source window likely needs cleaning. Clean window following Step 2 under 2.3 (Section III). When the observed reading is within the required tolerances, the instrument is fully calibrated.

2.2 Sample Measurement

- Step 1:** Place function switch in 0-20 ppm range for field monitoring. This will allow for the most sensitive, quick response in detecting airborne contaminants.
- Step 2:** Before entering a contaminated area, determine background concentration. This concentration should be used as a reference to readings made in the contaminated area. Under no circumstance should one attempt to adjust the zero or span adjustments while the instrument is being operated in the field.
- Step 3:** Take measurements in contaminated area, recording readings and locations. Should readings exceed the 0-20 scale, switch the function

switch to the 0-200 or 0-2,000 range as appropriate to receive a direct reading. Return the instrument switch to the 0-20 range when readings are reduced to that level. Record measurements in notebook or on an appropriate form.

Step 4: Keep in mind health and safety action guidelines for the level of protection you are wearing. Sustained readings above a certain level may force you to vacate an area or upgrade your level of protection.

Note: The instrument will not function properly in high humidity or when the window to the light housing is dirty. If the instrument response is erratic or lower than expected.

Step 5: When finished, use the reverse Steps 1 thru 5 of Section 2.1.3.2 (Instrument Setup) to shut down the instrument.

III. MAINTENANCE AND TROUBLE-SHOOTING

1.0 Battery Recharging

1.1 The instrument should be recharged 1 hour for each hour of use or overnight for a full day's use. (The battery will last 10 hours on a full charge.)

1.2 To recharge the battery (or instrument):

1.2.1 Turn the function switch to the off position.

1.2.2 Remove the charger from the instrument top compartment.

1.2.3 Place the charger plug into the jack on the left side of the instrument box.

1.2.4 Connect the charger unit to a 120 V AC supply.

1.2.5 Check charger function by turning the instrument switch to the battery check position. The meter should go upscale if

the charger is working and is correctly inserted into the jack.

1.2.6 Place instrument in instrument mode and charge for the appropriate time period.

1.2.7 Turn the instrument off following the recharge cycle. When disconnecting charger, remove from 120 V AC supply before removing the mini phone plug.

2.0 General Fault Determination and Correction

2.1 Battery level is low. Recharge if necessary implementing steps described under 1.0 (Section III). If the battery will not recharge, it will have to be replaced.

2.2 UV Lamp function - Gaze at sample inlet when mode switch is on an instrument function position and observe for purple glow of lamp. If the lamp does not glow in any of the three instrument function positions, it may be burned out and will have to be replaced. To replace the lamp:

1. Turn the function switch to the off position and disconnect the probe connector from the readout unit.
2. Remove the exhaust screw found near the base of the probe (Figure 3).
3. Grasp the end cap in one hand and the probe shell in the other and gently pull to separate the end cap and lamp housing from the shell.
4. Loosen the screws on the top of the end cap and separate the end cap and ion chamber from the lamp and lamp housing. Care must be taken so that the ion chamber does not fall out of the end cap and the lamp does not slide out of the lamp housing.
5. Turn the end cap over in your hand and tap on the top of it; the ion chamber should fall out of it.
6. Place one hand over the top of the lamp housing and tilt slightly. The light source will slide out of the housing.
7. Replace lamp with one of same energy source as the one removed by sliding it into the

housing. Note: The amplifier board and instrument circuitry are calibrated for one light energy.

8. Place the ion chamber on top of the lamp housing, checking to ensure that the contacts are aligned.
9. Place the end cap on top of the ion chamber and replace the two screws. The screws should be tightened only enough to seal the "O" ring. Do not overtighten.
10. Line up the pins on the base of the lamp housing with the pins inside the probe shell. Gently slide the housing assembly into the probe shell. Do not force the assembly as it only fits one way.
11. Replace and tighten the exhaust screw.
12. Reconnect the 12 pin connector and turn instrument mode switch to a function position. Check for glow of lamp. If lamp still does not function, the instrument has an electrical short or other problem that will have to be corrected at the factory.

2.3 Instrument appears to be functional, but responses are lower than expected or erratic. The window of the light source may be dirty and need to be cleaned. To clean the light source window:

1. Disassemble the probe assembly by repeating Steps 1 thru 6 under 2.2 above.
2. Clean the window of the light source using compound provided with instrument and soft clean cloth. Important: Use cleaning compound on the window of the 10.2 eV lamp only. The cleaning compound may damage the windows of the 9.5 and 11.7 eV lamps.
3. Reassemble the probe assembly repeating Step 7 through 12 above.

3.0 Specific Faults

3.1 No meter response in any switch position (including BATT CHK)

1. Broken meter movement: Tip instrument rapidly from side to side. Meter needle should move freely, and return to zero.

2. Electrical connection to meter is broken: Check all wires leading to meter and clean the contacts of quick-disconnects.
3. Battery is completely dead: Disconnect battery and check voltage with a volt-ohm meter.
4. Check 2 amp fuse.
5. If none of the above solves the problem, consult the factory.

3.2 Meter responds in BATT CHK position, but reads zero or near zero for all others.

1. Power supply defective: Check power supply voltages per Figure 4. If any voltage is out of specification, consult the factory.
2. Input transistor or amplifier has failed: Rotate zero control; meter should deflect up/down as control is turned. Open probe; both transistors should be fully seated in sockets.
3. Input signal connection broken in probe or readout: Check input connector on printed circuit board. Should be firmly pressed down. Check components on back side of printed circuit board. All connections should be solid, and no wires should touch any other object. Check all wires in readout for solid connections.

3.3 Instrument responds correctly in BATT CHK, and STBY, but not in measuring mode.

1. Check to see the light source is on (See Section 2.2).
2. Check high voltage power supply (See Figure 4).
3. Open end of probe, remove lamp and check high voltage on lamp contact ring.
4. If high voltage is present at all above points, light source has most likely failed. Consult the factory.

3.4 Instrument responds correctly in all positions, but signal is lower than expected.

1. Check span setting for correct value.
 2. Clean window of light source (See 2.3).
 3. Double check preparation of standards.
 4. Check power supply 180 V output. See Figure 4.
 5. Check for proper fan operation. Check fan voltage. See Figure 4.
 6. Rotate span setting. Response should change if span pot is working properly.
- 3.5 Instrument responds in all switch positions, but is noisy (erratic meter movement).
1. Open circuit in feedback circuit. Consult the factory.
 2. Open circuit in cable shield or probe shield. Consult the factory.
- 3.6 Instrument response is slow and/or irreproducible.
1. Fan operating improperly. Check fan voltage. See Figure 4.
 2. Check calibration and operation.
- 3.7 Low battery indicator.
1. Indicator comes on if battery charge is low.
 2. Indicator also comes on if ionization voltage is too high.

APPENDIX J

**CALIBRATION AND MAINTENANCE OF
ORGANIC VAPOR ANALYZER (OVA)**

damaging the batteries. When finished, move the battery charger switch to OFF and disconnect from the Side Pack Assembly.

The following are special instructions relative to batteries which have been allowed to completely discharge.

It has been established that the above battery recharging procedures may not be sufficient when the operator of the instrument has inadvertently left the INSTR Switch ON for a period of time without recharging and allowed the battery to completely discharge.

When this happens and the above procedures fail to recharge the battery, the following should be accomplished:

- 1) Remove the battery from the instrument case.
- 2) Connect to any variable DC power supply.
- 3) Apply 40 volts at 1/2 amp maximum.
- 4) Observe the meter on the power supply frequently and as soon as the battery begins to draw current, reduce the voltage on the power supply at a slow rate until the meter reads approximately 15 volts. NOTE: The time required to reach the 15 volt reading will depend on degree of discharge.
- 5) Repeat steps a), b), c), and d) above to continue charging.

2.7.2 DC CHARGER

- a) The optional DC charger is designed to both charge the battery and to provide power for operating the instrument from a 12 volt DC source, such as vehicle power.
- b) Connect the DC charger cord to the connector on the battery cover of the Side Pack Assembly. Plug the line cord into the vehicle cigarette lighter or other power source connection.
- c) In mobile applications, the DC charger is used to supply vehicle power to the instrument. Therefore, it may be left connected at all times.

2.8 CHARCOAL FILTERING

When it is desired to preferentially remove the heavier hydrocarbons, such as those associated with automobile exhaust, gasoline, etc., simply remove the pickup fixture from the end of the probe and install the optional charcoal filter assembly.

This same charcoal filter assembly can be installed directly into the Readout Assembly by using the adapter provided.

2.9 MOISTURE FILTERING

Filtering of moisture in the sample is not normally required. However, when moving in and out of buildings in cold weather, excessive condensation can form in the lines and detector chamber. In this case, the charcoal filter adapter can be filled with a desiccant such as "Drierite" which will filter out the moisture contained in the sample.

SECTION 3

SUMMARIZED OPERATING PROCEDURES

3.1 GENERAL

The procedures presented in this section are intended for use by personnel generally familiar with the operation of the instrument. Section 2 presents the comprehensive detailed operating procedures.

It is assumed that, prior to start up the positions of all switches and valves are in shut down configuration as described in paragraph 3.3.

3.2 START UP

- a) Move PUMP Switch to ON and check battery condition by moving the INSTR Switch to the BATT position.
- b) Move INSTR Switch to ON and allow five (5) minutes for warm-up.
- c) Set Alarm Level Adjust Knob on back of Readout Assembly to desired level.
- d) Set CALIBRATE Switch to X10 position, use CALIBRATE Knob and set meter to read 0.
- e) Move PUMP Switch to ON position then place instrument panel in vertical position and check SAMPLE FLOW RATE indication.
- f) Open the H2 TANK VALVE and the H2 SUPPLY VALVE.
- g) Depress Igniter Button until burner lights. Do not depress Igniter Button for more than six (6) seconds. (If burner does not ignite, let instrument run for several minutes and again attempt ignition.)
- h) Use CALIBRATE Knob to "zero" out ambient background. For maximum sensitivity below 10 ppm, set CALIBRATE Switch to X1 and readjust zero on meter. To avoid false flame-out alarm indication, set meter to 1 ppm with CALIBRATE Knob and make differential readings from there.

3.3 SHUT DOWN

- a) Close the H2 SUPPLY VALVE and the H2 TANK VALVE.
- b) Move the INSTR Switch and PUMP Switch to OFF.
- c) Instrument is now in shut down configuration.

SECTION 4

CALIBRATION

4.1 GENERAL

The OVA is capable of responding to nearly all organic compounds. For precise analyses it will be necessary to calibrate the instrument with the specific compound of interest. This is especially true for materials containing elements other than carbon and hydrogen.

The instrument is factory calibrated to a methane in air standard. However, it can be easily and rapidly calibrated to a variety of organic compounds. A GAS SELECT control is incorporated on the instrument panel which is used to set the electronic gain to a particular organic compound.

Internal electronic adjustments are provided to calibrate and align the electronic circuits. There are four (4) such adjustments all located on the electronics board. One adjustment potentiometer, R-38, is used to set the power supply voltage and is a one-time factory adjustment. The remaining three adjustments, R-31, R-32 and R-33 are used for setting the electronic amplifier gain for each of the three (3) calibrate ranges. Access to the adjustments is accomplished by removing the instrument from its case. Figure 4-1 indicates the location of the adjustments.

4.2 ELECTRONIC ADJUSTMENTS

Primary calibration of this instrument is accomplished at the factory using methane in air sample gases.

4.2.1 GAIN ADJUSTMENT

- Place instrument in normal operation with CALIBRATE Switch set to X10 and GAS SELECT control set to 300.
- Use the CALIBRATE ADJUST (zero) Knob and adjust the meter reading to zero.
- Introduce a methane sample of a known concentration (near 100 ppm) and adjust trimpot R-32 on circuit board (see Figure 4-1 for location) so that meter reads equivalent to the known sample.
- This sets the instrument gain for methane with the panel mounted gain adjustment (GAS SELECT) set at a reference number of 300.
- Turn off H2 SUPPLY VALVE to put out flame.

4.2.2 BIAS ADJUSTMENT

- Leave CALIBRATE Switch on X10 position and use CALIBRATE ADJUST (zero) Knob to adjust meter reading to 4 ppm.
- Place CALIBRATE Switch in X1 position and, using trimpot R-31 on circuit board, adjust meter reading to 4 ppm. (See Figure 4-1)
- Move CALIBRATE Switch to X10 position again. Use CALIBRATE ADJUST (zero) Knob to adjust meter to a reading of 40 ppm.
- Move CALIBRATE Switch to X100 position and use trimpot R-33 on circuit board to adjust meter reading to 40 ppm.
- Move CALIBRATE Switch to X10 position and use CALIBRATE ADJUST (zero) Knob to adjust meter reading to zero.
- Unit is now balanced from range to range, calibrated to methane, and ready to be placed in normal service.

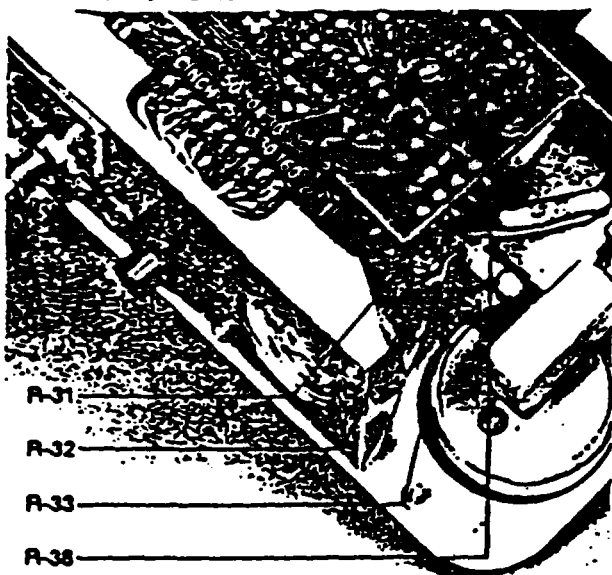


FIGURE 4-1. LOCATION OF ELECTRONIC ADJUSTMENTS
(Model OVA-118 shown; location typical to OVA-128)

4.3 CALIBRATION TO OTHER ORGANIC VAPORS

4.3.1 SETTING GAS SELECT CONTROL (Span)

Primary calibration of the instrument is accomplished using a known mixture of a specific organic vapor compound. After the instrument is in operation and the "normal background" is "zeroed out", draw a sample of the calibration gas into the instrument. The GAS SELECT Knob on the panel is then used to shift the readout meter indication to correspond to the concentration of the calibration gas mixture.

The instrument is then calibrated for the vapor mixture being used. After this adjustment, the setting on the "digital" is read and recorded for that particular organic vapor compound. This exercise can be performed for a large variety of compounds and when desiring to read a particular compound the GAS SELECT control is turned to the predetermined setting for the compound. Calibration on any one range automatically calibrates the other two ranges.

4.3.2 USING EMPIRICAL DATA

Relative response data may be obtained, which can then be used to estimate concentrations of various vapors. With the instrument calibrated to methane, obtain the concentration reading for a calibration sample of the test vapor. The relative response, in percent, for that test vapor would then be the concentration read/concentration of the calibrated sample X 100.

4.3.3 PREPARATION OF CALIBRATION STANDARDS

4.3.3.1 COMMERCIAL SAMPLES

Commercially available standard samples offer the most convenient and reliable calibration standards and are recommended for the most precise analyses. Always remember to obtain the cylinder with the desired sample and the "balance as air". Sample should be drawn from the cylinder into a collapsed sample bag, then drawn from the bag by the instrument to prevent a pressure or vacuum at the sample inlet.

4.3.3.2 PURE GASEOUS SAMPLES

Obtain a large collapsible sample bag, preferably polyethylene such as a 40 gallon trash can liner. Insert a tube into the bag opening and tie shut around the tube. The tubing should have a shut-off valve or plug and be suitable for connecting the OVA input tube. Determine the volume of the bag by appropriate means (i.e., wet-test meter, dimensions of inc. bag, etc.). Forty gallon polyethylene bags provide a volume of approximately 140-160 liters. For gas samples, flush a 10 cc hypodermic syringe with the compound to be tested and then inject a 10 cc sample through the wall of the air-filled bag. Immediately after withdrawing the needle, cover the hole with a piece of plastic tape. Allow a few minutes for the sample to completely diffuse throughout the bag. Agitation will ensure complete diffusion. Connect the outlet tube to the OVA and take a reading. To verify repeatability of sampling technique, disconnect the bag and inject a second sample of the gas into the bag without emptying. Since only 2 or 3 liters will have been removed, the overall volume change will be small and the instrument reading should now be twice that of the

original. The concentration in ppm (V/V) will be equal to the sample size in cc divided by the volume of the bag in liters times 1000. For example, a 10 cc gas sample when placed in a 160 liter bag will provide a sample of 63 ppm, i.e., $10 \times 1000/160$ equals 63 ppm.

3.3.3 GASEOUS AND LIQUID SAMPLES (Alternate Method)

Obtain a five (5) gallon glass bottle and determine its volume by measuring the volume of water needed to fill it (use of a 1000 ml graduated cylinder, obtainable from scientific supply houses, is convenient). Another approach is to weigh the empty bottle, fill it with water and weigh again. The difference between the two values is the weight of water. By multiplying the weight of water in pounds by 0.453, you obtain the volume of the bottle in liters. Empty the water out and allow the bottle to dry. Place a one-foot piece of plastic tubing in the flask to aid in mixing the vapors uniformly with the air. The volume of such a bottle should be about 20 liters, which is 20,000 ml. If the volume were 20,000 ml, then a 2 ml sample of a gas placed in the bottle would be equivalent to 200 ml per 2 million ml or 100 ppm (V/V). Use of a gas tight syringe, readable in 0.01 ml, allows the preparation of mixtures in the 1 - 2 ppm range, which are sufficient for the quantitative estimation of concentrations. A rubber stopper is loosely fitted to the top of the bottle and the needle of the syringe placed inside the jug neck and the stopper squeezed against the needle to decrease leakage during sample introduction. Inject the sample into the bottle and withdraw the needle without removing the stopper. Put the stopper in tight and shake the bottle for a few minutes with sufficient vigor that the plastic tubing in the bottle moves around to ensure good mixture of the vapors with the air.

For liquid samples, use of the following equation will allow the calculation of the number of microliters of organic liquid needed to be placed into the bottle to make 100 ppm (V/V) of vapor.

$$V1 \text{ equals } V2 \times Mw/2440$$

V1 - Volume of liquid in microliters needed to make an air mixture of 100 ppm (V/V)

V2 - Volume of bottle in liters

Mw - Molecular weight of substance

D - Density of substance

This procedure has the advantage that you can see when all of the organic liquid has vaporized and the volume can be determined readily.

For liquid samples, an alternate procedure involves the use of a diffusion dilution device such as that described by Desty, Geach and Goldup in "Gas Chromatography", R.P.W. Scott, ed., Academic Press, New York, 1961.

4.4 THEORY

Theoretical background and empirical data related to the Century Organic Vapor Analyzer is presented in 4.4.1 and 4.4.2.

4.4.1 HYDROCARBONS

In general, a hydrogen flame ionization detector is more sensitive for hydrocarbons than any other class of organic compounds. The response of the OVA varies from compound to compound, but gives excellent repeatable results with all types of hydrocarbons; i.e., saturated hydrocarbons (alkanes), unsaturated hydrocarbons (alkenes and alkynes) and aromatic hydrocarbons.

The typical relative response of various hydrocarbons to methane is as follows:

Compound	Relative Response (percent)
Methane	100 (reference)
Propane	64
N-butane	61
N-pentane	100
Ethylene	85
Acetylene	200
Benzene	150
Toluene	120
Ethane	90

4.4.2 OTHER ORGANIC COMPOUNDS

Compounds containing oxygen, such as alcohols, ethers, aldehydes, carboxylic acid and esters give a somewhat lower response than that observed for hydrocarbons. This is particularly noticeable with those compounds having a high ratio of oxygen to carbon such as found in the lower members of each series which have only one, two or three carbons. With compounds containing higher numbers of carbons, the effect of the oxygen is diminished to such an extent that the response is similar to that of the corresponding hydrocarbons.

Nitrogen-containing compounds (i.e., amines, amides and nitriles) respond in a manner similar to that observed for oxygenated materials. Halogenated compounds also show a lower relative response as compared with hydrocarbons. Materials containing no hydrogen, such as carbon tetrachloride, give the lowest response; the presence of hydrogen in the compounds results in higher relative responses. Thus, CHCl_3 gives a much higher response than does CCl_4 . As in the other cases, when the carbon to halogen ratio is 5:1 or greater, the response will be similar to that observed for simple hydrocarbons.

The typical relative response of various compounds to methane is as follows:

Methane	100 (calibration sample)
Ketones	
Acetone	60
Methyl ethyl ketone	80
Methyl isobutyl ketone	100
Alcohols	
Methyl alcohol	15
Ethyl	25
Isopropyl	65

Halogen compounds

Carbon tetrachloride	10
Chloroform	65
Trichloroethylene	70
Vinyl chloride	35

The OVA has negligible response to carbon monoxide and carbon dioxide which evidently, due to their structure, do not product appreciable ions in the detector flame. Thus, other organic materials may be analyzed in the presence of CO and CO₂.

SECTION 5

SAFETY CONSIDERATIONS

5.1 GENERAL

The Models OVA-108, OVA-128 and OVA-138 have been tested and certified by Factory Mutual Research Corporation (FM) as intrinsically safe for use in Class I, Division 1, Groups A, B, C & D hazardous atmospheres. Similar foreign certifications have been obtained, including BASEEFA and Cerchar approval for Group IIC, Temperature Class T4 on the Models OVA-108, OVA-128 and OVA-138, and equivalent approval from the Japanese Ministry of Labor for the Model OVA-128. Special restrictions must be strictly adhered to, to ensure the certification is not invalidated by actions of operating or service personnel.

All flame ionization hydrocarbon detectors are potentially hazardous since they burn hydrogen (H₂) or H₂ mixtures in the detector cell. Mixtures of H₂ and air are flammable over a wide range of concentrations whether an inert gas such as nitrogen (N₂) is present or not. Therefore, the recommended precautions and procedures should be followed for maximum safety. Safety considerations was a major factor in the design of the Organic Vapor Analyzer (OVA).

All connectors are of the permanent type as opposed to quick disconnect. To protect against external ignition of flammable gas mixtures, the flame detection chamber has porous metal flame arrestors on the sample input and the exhaust ports as well as on the H₂ inlet connector. The standard battery pack and other circuits are internally current limited to an intrinsically safe level.

5.2 OPERATING, SERVICING AND MODIFYING

It is imperative that operation and service procedures described in this manual be carefully followed in order to maintain the intrinsic safety which is built into the OVA. No modification to the instrument is permissible. Therefore, component replacement must be accomplished with the same type parts.

5.3 ELECTRICAL PROTECTION

The 12V battery power supply circuit is current limited to an intrinsically safe level. Fuses are not utilized and all current limiting resistors and other components which are critical to the safety certification are encapsulated to prevent inadvertent replacement with components of the wrong value or specification. Under no circumstances should the encapsulation be removed.

5.4 FUEL SUPPLY & TANK

The OVA fuel tank has a volume of 75 to 85 cc which, when filled to the maximum rated pressure of 2300 PSIG, holds approximately 5/8 cubic foot of gas. The fuel used in the OVA is pure hydrogen which can be readily purchased in a highly pure form at nominal cost. The H₂ tanks used in the instrument are made from stainless steel, proof-tested to 8,000 PSIG and 100% production tested to 4,000 PSIG.

5.5 H₂ FLOW RESTRICTORS

Hydrogen gas gains heat when expanding and, therefore, should not be rapidly released from a high pressure tank to a low pressure environment. Flow restrictors are incorporated in the H₂ refill fitting and H₂ is restricted on the output side of the tank by the low flow rate control system. In addition, a special flow restrictor is incorporated in the FILL/BLEED valve of the hydrogen filling hose assembly. These precautions limit the flow rate of the H₂ to prevent ignition due to self-heat from expansion.

5.6 DETECTOR CHAMBER

The OVA has a small flame ionization chamber cavity with sintered metal flame arrestors on both the input and output ports. The chamber is ruggedly constructed of teflon such that even if highly explosive mixtures of H₂ and air are inadvertently created in the chamber and ignited, the chamber would NOT rupture.

5.7 H₂ FILLING AND EMPTYING OPERATIONS

Precautions should be taken during H₂ filling or H₂ tank emptying operations to ensure that there are no sources of ignition in the immediate area. Since the instrument tank at 2300 PSIG holds only 5/8 cu. ft. of H₂, the total quantity, if released to the atmosphere, would be quickly diluted to a non-flammable level. There is, however, the possibility of generating flammable mixtures in the immediate vicinity of the instrument during the filling or emptying operations if normal care is not exercised.

5.8 VENTING

The OVA case is vented to eliminate the possibility of trapping an explosive mixture of H₂ and air inside the case.

SECTION 8

MAINTENANCE

8.1 GENERAL

This section describes the routine maintenance schedule recommended and provides procedures for trouble shooting malfunctions or failures in the instrument.

Appendix "A" to this manual contains the assembly drawings and associated parts list for the Side Pack Assembly and two major subassemblies; the Electronic Component Assembly and the Cylinder Assembly. These drawings and parts lists may be used for locating and identifying components. Also included in Appendix "A" is a schematic wiring diagram showing interconnecting wiring between major electronic assemblies and typical signal levels at selected points on the certified instruments. The enclosed drawings and parts lists are subject to change without notice and part replacement on any certified instrument should be limited to comply with the "no modifications permitted" requirement.

CAUTION

Maintenance personnel should be thoroughly familiar with instrument operation before performing maintenance. It is essential that all portions of this manual relating to safety of operation, servicing and maintenance, including Section 5, be thoroughly understood. There should be no poten-

tial igniters or flame in the area when filling, emptying or purging the hydrogen system and the instrument should be turned off.

Extreme care should be exercised to ensure that required parts replacement is accomplished with the same parts specified by Century. This is especially necessary on the Models OVA-108, OVA-128 and OVA-138 in order that their certification for use in hazardous atmospheres be maintained. No modifications are permitted. Disassemble instrument only in a non-hazardous atmosphere.

8.2 ROUTINE MAINTENANCE

Note that Figure 6-1 is a flow diagram of the basic gas handling system.

8.2.1 FILTERS

8.2.1.1 PRIMARY FILTER

This filter is located behind the sample inlet connector (Fitting Assembly) on the Side Pack Assembly and is removed for cleaning by using a thin wall socket to unscrew the Fitting Assembly. The filter cup, "O" ring and loading spring will then come out as shown in the Side Pack Assembly drawing in Appendix "A". The Side Pack Assembly drawing can then be cleaned by blow-porous stainless filter cup can then be cleaned by blowing out or washing in a solvent. If a solvent is used, care should be taken to ensure that all solvent is removed by blowing out or heating the filter. Reassemble in reverse order ensuring that the "O" ring seal on the Fitting Assembly is intact.

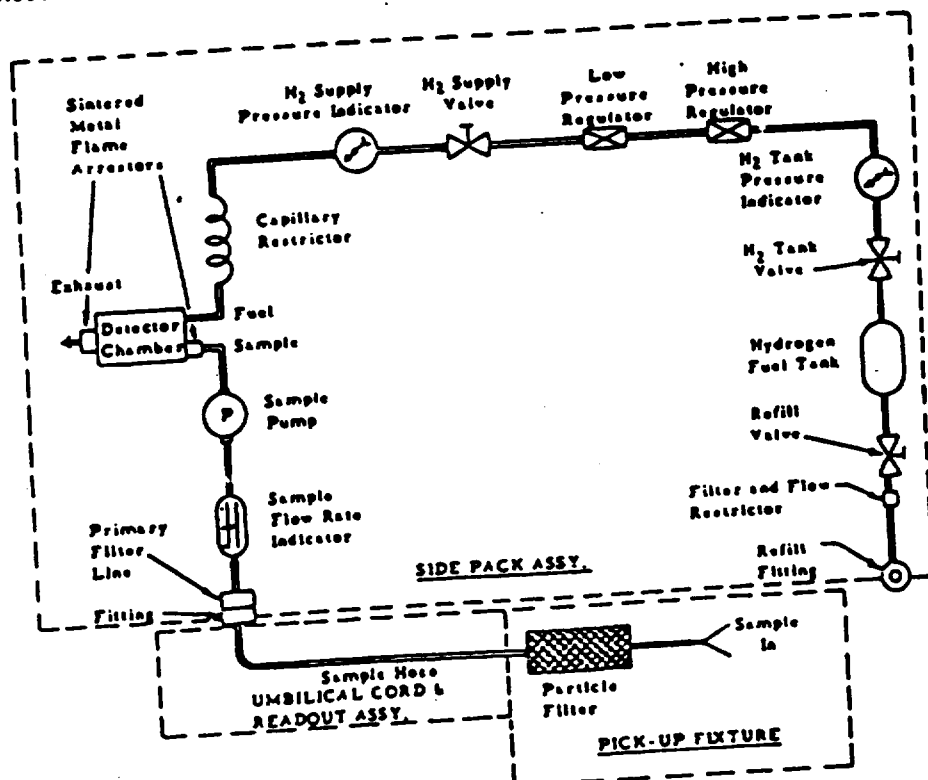


FIGURE 6-1. Flow Diagram - Gas Handling System

6.2.1.2 PARTICLE FILTERS

A particle filter is located in each pickup fixture. One of these filters must be in the sample line whenever the instrument is in use. The Models OVA-88 and OVA-138 use a disposable cellulose filter which should be changed as often as required. The Models OVA-98, OVA-108, OVA-118 and OVA-128 use a porous metal filter which can be replaced or cleaned using the cleaning procedure in paragraph 6.2.1.1.

6.2.1.3 MIXER/BURNER ASSEMBLY FILTER

Another porous metal particle filter is incorporated in the Mixer/Burner Assembly which screws into the Preamp Assembly. See Side Pack Assembly drawing. This filter is used as the sample mixer and inlet flame arrestor in the chamber. This filter should not become contaminated under normal conditions but can be cleaned or the assembly replaced if necessary.

Access to this filter for output surface cleaning is gained by simply unscrewing the exhaust port from the Preamp Assembly without removing the instrument from the case. The OVA-108, OVA-128 and OVA-138 instruments require removal of the safety cover prior to unscrewing the exhaust port. The Filter Assembly can now be seen on the side of the chamber (Preamp Assembly) and can be scrapped or cleaned with a small wire brush.

If filter replacement is required, install a new or factory rebuilt Mixer/Burner Assembly. In several OVA models, this requires removal of the Preamp Assembly.

6.2.1.4 EXHAUST FLAME ARRESTOR

A porous metal flame arrestor is located in the exhaust port of the detector chamber (Preamp Assembly). See Side Pack Assembly drawing. It acts as a particle filter on the chamber output and restricts foreign matter from entering the chamber. This filter may be cleaned, if required, by removing the exhaust port from the Preamp Assembly. The exhaust port is removed from the bottom of the case without case removal. Note that the filter is captive to the exhaust port on the Models OVA-108, OVA-128 and OVA-138. Clean the filter with a solvent or detergent but ensure that it is dry and any solvent completely baked out at 120°F before reinstalling.

6.2.2 PICKUP FIXTURES

The pickup fixtures should be periodically cleaned with an air hose and/or detergent water to eliminate foreign particle matter. If a solvent is used, the fixture should be subsequently cleaned with detergent and baked out at 120°F to eliminate any residual hydrocarbons from the solvent.

6.2.3 SEAL MAINTENANCE - CYLINDER ASSEMBLY

6.2.3.1 H₂ TANK, H₂ SUPPLY AND REFILL VALVES

After some time, the teflon washers under each valve packing nut can "cold flow" (move with pressure) and allow hydrogen to leak. Leakage can be determined by using Leak-Tec, Snoop or a soap solution around the valve stems. This leakage can usually be stopped by tightening the compression nut (adapter) as outlined

below. See Side Pack Assembly and Cylinder Assembly drawings.

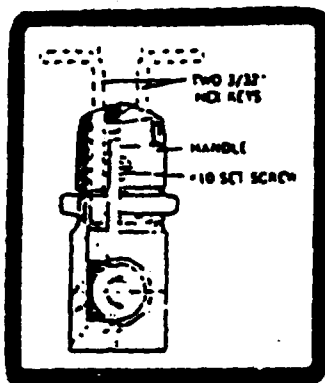
- 1) Remove instrument from the case by unlocking the four (4) 1/4 turn fasteners on the panel and removing the exhaust safety cover (if included), exhaust port and refill cap nut. Be sure refill valve is closed before removing refill cap nut.
- 2) Remove the valve knob screw and knob.
- 3) Loosen the panel nut with a 3/4" wrench.
- 4) The valve compression nut is located just under the panel. Tighten the compression nut—usually not more than 1/4 turn.

This compression is against soft material and only a small amount of force is necessary to sufficiently compress the teflon washers. If, after tightening, leakage still occurs, it would be advisable to replace the two teflon washers, as follows:

- 1) Drain hydrogen system slowly and to the extent necessary to work on the leaking valve(s). Observe safety precautions (see Section 5). There should be no potential igniters in the area.
- 2) Disconnect the capillary tube from the manifold at low pressure gauge (H₂ Supply Pressure).
- 3) Remove all three (3) knob screws and knobs.
- 4) Remove the three (3) panel nuts and washers.
- 5) Carefully remove the tank assembly from the panel. NOTE: If OVA has GC Option installed, the GC valve assembly must be loosened or removed in order to remove the tank assembly from the panel.
- 6) Remove the compression nut on the valve that is not sealing properly. Remove the stem by unscrewing it from the valve body. Observe the sandwich of metal and teflon washers and note their order.
- 7) Visually check the Kel-F seal on the stem for cracks or foreign material. Wipe clean, if necessary, with a lint free cloth (no solvents or oils) and replace if damaged.
- 8) Remove the washers and replace the teflon washers (the factory procedure is a light wipe of hydrocarbon free silicone grease).
- 9) Replace the stem assembly in the valve body and tighten lightly.
- 10) Push the washers down into the compression area in the same order as noted upon removal. Replace the compression nut and tighten snugly.
- 11) Close the low pressure valve and fill the tank assembly. Check valves for leaks. Tighten again, if necessary, and reassemble the unit.

6.2.3.2 REFILLER VALVE PACKING ADJUSTMENT

Adjustment for the valve on the refiller can be made by loosening the set screw with a 3/32" hex key, so that the handle turns freely on the stem. Insert two (2) 3/32" hex keys through the holes provided in the handle and turn until they engage the holes in the packing adjuster. Then tighten the packing by turning the handle.



6.2.4 AIR SAMPLING SYSTEM MAINTENANCE

6.2.4.1 GENERAL

A potential problem associated with the OVA instrument is that leaks can develop in the air sample pumping system. These leaks can result in either dilution or loss of sample, causing low reading of vapor concentration and slow response time.

6.2.4.2 TESTING FOR LEAKS

The OVA's are equipped with a flow gauge, which provides a method to check for air leaks. Assemble the pickup probe selected for use to the readout assembly and then position the sidepack vertically so the flow gauge may be observed. Cover the end of the pickup probe with your finger and observe that the ball in the flow gauge goes to the bottom, indicating no air flow (if ball has slight chatter while on bottom, this is acceptable). Cover the center of the chamber exhaust port with your thumb and again observe the ball going to the bottom. Another simple check is to expose the pickup probe to cigarette smoke or a light vapor (butane) and observe that the meter responds in approximately 1.5 - 2.0 seconds. It should be noted that slow meter response may also indicate a restriction in the air sampling system.

6.2.4.3 LEAK ISOLATION

Failure of the ball to go to the bottom when the inlet is blocked indicates a leak in the system between the probe and the pump inlet or the inlet check valve. To isolate the problem, remove parts, one at a time, and again block off the air inlet. Remove the pickup probe(s) and cover the air inlet at the Readout Assembly. If the ball goes to the bottom, check that the "readout to probe" seal washer is in place and replace the probes, holding them back against this seal while tightening the nut. Recheck, and if leakage is still present, it is probably in the probe (pickup fixture), which should be repaired or replaced.

If leakage is indicated as being past the readout handle when the connection to the sidepack is tight, disconnect the sample line at the fitting on the sidepack and cover this inlet with your finger. If the flow gauge

ball goes to the bottom, the problem should be a leak in the umbilical cord/Readout Assembly, which should be investigated and repaired. There is also the possibility of a leaking check valve in the pump which would not show up on this test. If the leakage is not found in the umbilical cord, it is most likely in the pump check valve which should be repaired or replaced.

If the ball does not go to the bottom, the leak will be either in the flow gauge or its connecting tubing. Visually check that the tubing is connected and if so, the flow gauge should be repaired or replaced. Check the "O" ring installation in the sample inlet connector (Fitting Assembly).

As an alternate approach, leaks on the inlet side of the pump can be detected by using alcohol on a "Q" Tip and lightly swabbing the connections one at a time or by directing organic vapor or smoke at the potential leakage points and observing the meter response or audible alarm.

Leaks (beyond the pump) are easier to locate, as any of the commercially available leak detection solutions can be used. Cover the exhaust port, which will place the exhaust system under pressure, and check each connection, one at a time. Replace the teflon tubing or retape the threaded connections with teflon joint tape. Check the igniter and Mixer/Burner Assembly where they screw into the detector, the high voltage terminal screw on the side of the Mixer/Burner and exhaust port itself. If after these checks, the flow gauge ball still will not go to the bottom with the exhaust blocked, the problem is likely a leaking exhaust check valve in the pump, which should be repaired or replaced.

6.2.5 CONTAMINATION CONTROL AND MAINTENANCE

6.2.5.1 GENERAL

On occasion, the background reading of the OVA may be relatively high under normal ambient conditions. Ambient background readings will vary somewhat depending on the geographical location where the instrument is being used. However, the background reading normally should be in the range of 3 to 5 ppm as methane. The acceptable background reading consists of 1 to 1-1/2 ppm of methane which is present in the normal air environment. In addition to the measurement of a normal methane background, there will normally be 2 to 4 ppm of equivalent methane background caused by acceptable levels of contamination in the hydrogen fuel and/or hydrogen fuel handling system resulting in a total equivalent methane reading of 3 to 5 ppm in clean air.

If the background reading goes above 5 ppm to 6 or 7 ppm, this is normally still acceptable since any measurement is additive to that background reading, i.e., 2 ppm on top of 5 or 2 ppm on top of 7 provides the same differential reading, however, the lower background is obviously desirable.

The background reading on the linear OVA's is zeroed out or nulled out—even though in reality the background still exists. The background reading on the

linear OVA's is measured by zeroing the meter with the flame out and noting the meter indication after the flame is on. However, on the logarithmic scaled OVA's the background reading is observed on the meter at all times. This is considered desirable since it assures the operator that the instrument is, in fact, operating properly. The background reading on the OVA's serves as a low level calibration point since it does represent the measurement of ambient levels of methane in the air, which are extremely stable and predictable any place in the world.

The cause for a high background reading is usually associated with contamination in the hydrogen fuel system. This will, of course, cause a background reading since this is the function of the basic detector "to measure contamination entering the detector chamber". In addition, contamination present in the hydrogen will many times leave a small unobservable deposit on the burner face which can continue to generate a background reading when the detector is in operation and the burner assembly is heated.

Another possible cause of contamination is the mixer/burner assembly when the contamination is trapped in the porous bronze sample filter. This is not a common problem and usually only happens when an unusually high level of contaminant is drawn into the assembly. Another possible cause of high background reading is contamination someplace in the air sample line to the detector. This is also uncommon but can be the source of the problem.

NOTE

OVA's that include the Chromatograph Option installed can also have an indication of high background related to saturation or contamination of the activated charcoal filter, which is in the line during chromatograph analysis, or of the column which is in the hydrogen line at all times.

6.2.5.2 ANALYSIS AND CORRECTION

Prior to analyzing the problem, the OVA should be checked for proper electronic operation. Check logarithmic instruments for proper high and low calibration points and for proper gas selector operation (see Section 4). On logarithmic OVA's, check Gas Selector by turning to 500 and observing the flame-out alarm comes on as the needle goes below 1 ppm. It should be ensured that the instrument is calibrated to methane as referenced.

If, after checking that the OVA is properly calibrated, the background is still higher than normal for ambient conditions, the following procedure should be followed to isolate the cause of the problem.

- 1) Let the OVA run for a period of time (15 to 30 minutes) and see if the background level decreases as a function of time. The background could go down and stay down as a result of clearing line contamination which is removable simply by the normal flow of air through the sample line.
- 2) Take a reading in a known, relatively clean air environment. Normally, outside air environ-

ment is clean enough to assess by comparison whether the background reading is internal to the instrument or is present in the laboratory, office or location where the instrument is being used.

- 3) If the OVA includes the Gas Chromatograph Option, depress the sample inject valve so that the activated charcoal is in the line and observe whether the background reading goes down and stays steady after the elution of the air peak. The reading should always go down or stay the same but never be a higher background reading with the sample valve depressed, since the charcoal filter will take out any trace elements of organic vapors in the air heavier than a C₂. If another activated charcoal filter is available, this may be attached to the end of the probe to scrub the air so that a clean air sample would be going to the detector. The external activated charcoal can be used on any instrument, with or without chromatograph, for providing a clean air sample to assess background level.
- 4) If background still stays up and cannot be reduced by any of the previous steps, the safety cover (if included) and the exhaust port on the detector chamber (Preamp Assembly) on the bottom of the case should be removed and the Mixer/Burner Assembly scraped or brushed with a small wire brush. (Reference paragraph 6.2.1.3.) This will remove any small quantities of contamination that are on the Mixer/Burner Assembly which could be the source of the background vapor. After cleaning the face of the burner and tube, replace the exhaust port and safety cover (if included) and reignite the OVA. If contamination on the burner face was the cause, the problem should be immediately resolved and the ambient background will drop to an acceptable level.
- 5) If the background is still present, place your finger over the inlet of the probe so as to reduce the flow of air to the detector chamber. Reduced flow rate may be observed either on the sample flow gauge or can normally be observed by the sound of the pump motor.
- 6) If the background drops immediately in response to the reduced flow of air to the chamber, this is an indication that the contamination is in the air sample line. Therefore, the various parts of the sample flow line such as pickup probes, umbilical cord to the instrument, etc., should be investigated by the process of elimination to see if the contamination can be isolated.
- 7) Serious contamination in the air sample line is very uncommon. However, if very large doses of very heavy compounds are sampled, there is a possibility of a residual contamination which would eventually clear itself out but may take a considerable period of time. A typical cause for the high background from the sample line is a

contaminated Mixer/Burner Assembly. See paragraph (4) above for cleaning procedure. If heavy contamination of the Mixer/Burner is still indicated by a high background, replace the Mixer/Burner Assembly. In several OVA models, this will require removal of the Preamp Assembly. The old Mixer/Burner Assembly should be either discarded or returned to the factory for cleaning and rebuilding.

- 8) In the event there is contamination in the pump or other internal parts of the sample flow lines which cannot be removed, the sample flow components would have to be disassembled and cleaned. This is normally a factory type operation. However, the components such as the pump can be replaced in the field along with any contaminated tubing in the sample lines.
- 9) High background readings on OVA's which include the Gas Chromatograph Option can be caused by other sources of contamination. If the charcoal in the charcoal filter mounted on the panel of the instrument is contaminated or saturated, contaminated air would be supplied to the detector and raise the ambient level background. To check for this, the charcoal filter cartridge can be removed from the panel and either a bypass tube put between the two connectors or the charcoal can be removed from the charcoal cartridge and the cartridge refilled with clean activated charcoal. This would determine if the charcoal was the source of the background reading. It is possible that an apparent high background reading could be due to contamination in the column that is on the instrument. This background could be caused by compounds that are slowly eluting from a column which has become contaminated. The easiest way to check for column contamination is to replace the column with a known clean column or a short empty piece of column tubing and see if the high background reading drops.
- 10) If all the above steps do not correct the high background problem, the cause will normally be contamination in the hydrogen fuel system.

Contamination in the hydrogen fuel system is usually the direct result of contamination in the hydrogen gas used or contamination introduced during the filling operation. Filling hose contamination can be caused by storing the hose in a contaminated area.

To remove contamination from the hydrogen fuel system, it should be purged with hydrogen. Effective purging of the hydrogen system is accomplished by disconnecting the capillary tube fitting which attaches on to the manifold block which has the low pressure gauge (H2 Supply Pressure Gauge and H2 Supply valve). This disconnects the capillary tubing from the hydrogen line so that hydrogen may be purged at a reasonable rate from the tank assembly through the regulators, gauges and valves. After disconnecting the capillary, the hydrogen tank can be filled in the normal

manner. The tank valve and H2 supply valve can then be opened which will bleed the hydrogen from the tank through the H2 fuel system purging out the contamination which is in vapor form. There is the possibility that contamination has been introduced into the hydrogen fuel system which is not readily purged out by the hydrogen gas but this is unlikely. After purging with clean hydrogen, approximately two or three times, the capillary tube should be reconnected and the background again checked. Five or ten minutes should be allowed before assessing the background reading, since contaminated hydrogen may still have been trapped in the capillary tube.

If another tank assembly in a clean instrument is available, the fuel system from the clean instrument can be connected to the contaminated instrument to absolutely verify that it is or is not in the hydrogen fuel supply system. The interconnection should be made to the capillary tube of the contaminated instrument.

6.2.6 FUSE REPLACEMENT

This paragraph applies only to the standard (non-certified) OVA's. There are two (2) overload fuses incorporated in the Battery Pack Assembly, one is a JAG-1 AMP Slo-Blo in the power line to the pump and igniter and the other a JAG-1/4 AMP in the power line to the electronics. Both fuses follow the current limiting resistors which provide primary short circuit protection. However, in the event of an excessive overload, the fuses will open and prevent overheating of the current limiting resistors. It should be pointed out that the 1 AMP Slo-Blo fuse will blow in approximately 8 to 12 seconds if the igniter switch is kept depressed. Normal ignition should take place in not more than 6 seconds. Therefore, do not depress igniter button for more than 6 seconds. If ignition does not occur, wait 1 to 2 minutes and try again. If the required 1 AMP Slo-Blo fuse cannot be readily obtained, replace temporarily with a 3 AMP-3 AG standard fuse.

6.3 TROUBLE SHOOTING

Table 6-1 presents a summary of recommended field trouble shooting procedures. If necessary, the instrument can be easily removed from the case by unlocking the four (4) 1/4 turn fasteners on the panel face and removing the refill cap and exhaust port. The battery pack is removed by taking out the four (4) screws on the panel and disconnecting the power connector at the battery pack.

6.4 FACTORY MAINTENANCE

To ensure continuous trouble-free operation, Century recommends a periodic factory maintenance, overhaul and recalibration. The recommended schedule is every six (6) to nine (9) months. This maintenance program includes replacement of plastic seals and parts as required, pump overhaul, motor check, new batteries, sample line cleaning, H2 leak check, recalibration, replacement of plastic hose as required, and detailed examination of the unit for any other required maintenance and repair.

The recommended procedure for maintenance and repair beyond the scope of this manual is to send the complete instrument or subassembly to the Century factory for repairs. The assemblies will be handled expeditiously for rapid turn-around.

8.5 FIELD MAINTENANCE

Although not recommended, where field maintenance beyond that described herein is considered essential, the assembly drawings, parts lists and schematics in Appendix "A" will be of assistance.

8.6 RECOMMENDED SPARES

Century does not recommend that spares be maintained for its instruments. However, if the instrument is to be used in a remote area or spares are desired for other reasons, the following list should be used as a guide.

RECOMMENDED SPARES

Item	Description	Part No.	Recommended Quantity					
			Standard			Approved		
			88	98	118	108	128	138
1	Igniter	510027-1	2	2	2			
2	Igniter	510461-1				2	2	2
3	Pump Valve	510067-3 (10/pkg.)	1	1	1	1	1	1
4	Pump Diaphragm (Buna-N)	510091-1	1					1
5	Pump Diaphragm (Teflon)	510063-1		1	1	1	1	
6	Cup, Filter (1/8 OD, SS)	510318-1 (5/pkg.)	1	1	1	1	1	1
7	Mixer/Burner Assy	510557-2	1					
8	Mixer/Burner Assy	510557-1		1	1			
9	Mixer/Burner Assy	510513-1				1	1	1
10	Wafer, Teflon, H ₂ Valve	510160-1 (10/pkg.)	1	1	1	1	1	1
11	Washer, Brass, H ₂ Valve	510160-2 (10/pkg.)	1	1	1	1	1	1
12	Exhaust Port Assy	510425-1	1	1	1			
13	Exhaust Port Assy	510530-1				1	1	1
14	Battery Pack Assy	510070-1	1	1	1			
15	Battery Pack Assy	510542-1				1	1	1
16	Sample Line Assy	510316-1		1	1	1	1	1
17	Particle Filters	510114-1	1					1
18	Particle Filters	510116-1		1	1	1	1	

NOTE: Unit quantity is each unless otherwise noted.

TABLE 6-1

TRouble

- 1) Low sample flow rate on flow indicator. Nominally 2 units on flow gauge. (See also 6 below and refer to paragraph 6.2.4)

TRouble SHOOTING PROCEDURE

- a) Check primary filter in sidepack and particle filters in the pickup assembly.
- b) Determine assembly containing restriction by process of elimination, i.e., remove probe, remove Readout Assembly, remove primary filter, etc.
- c) If the restriction is in the Side Pack Assembly, further isolate by disconnecting the sample flow tubing at various points, i.e., pump output, chamber input, etc.
Note: The inherent restrictions due to length of sample line, flame arrestors, etc., must be taken into account when trouble shooting.

REMEDY

Replace or clean filter if clogged. (See paragraph 6.2.1)

Investigate the assembly containing this restriction to determine cause of blockage. Clean or replace as required.

If in the detector chamber, remove and clean or replace porous metal flame arrestors. If pump is found to be the problem, remove and clean or replace.

- 2) H₂ flame will not light. (See also 6 below)

- a) Check sample flow rate (see 1 above).
- b) Check igniter by removing the chamber exhaust port and observing the glow when the IG-MITE Button is depressed.
- c) Check for rated H₂ Supply Pressure. (Listed on calibration plate on pump bracket.)
- d) Check H₂ flow rate by observing the PSI decrease in pressure on the H₂ Tank Pressure gauge. The flow rate should be about 130 PSI decrease in pressure per hour. (Approximately 12 cc/min. at detector.)
On instruments with GC Option, disconnect column and measure H₂ flow rate with a bubble meter.
- e) Check all H₂ plumbing joints for leaks using soap bubble solution. Also, shut off all valves and note pressure decay on H₂ tank gauge. It should be less than 350 PSIG per hour.
- f) Check to see if H₂ supply system is frozen up by taking unit into a warm area.

If sample flow rate is low, follow procedure 1 above.

If igniter does not light up, replace the plug. If igniter still does not light, check the battery and wiring.

If low, remove battery pack and adjust to proper level by turning the allen wrench adjustment on the low pressure regulator cap.

The normal cause for H₂ flow restriction would be a blocked or partially blocked capillary tube. If flow rate is marginally low, attempt to compensate by increasing the H₂ Supply Pressure by one-half or one PSI. If flow rate cannot be compensated for, replace capillary tubing.

Repair leaking joint.

If there is moisture in the H₂ supply system and the unit must be operated in subfreezing temperatures, purge the H₂ system with dry H₂ and ensure the H₂ gas used is dry.

check battery level by connecting to charger

If in cold zone, battery may not have enough power to light flame. (cold will drain battery, move it)

	<p>g) Remove exhaust port and check for contamination. (See Figure 6-2.)</p> <p>h) Check spacing between collecting electrode and burner tip. Spacing should be 0.1 to 0.15 inches.</p>	<p>If the chamber is dirty, clean with ethyl alcohol and dry by running pump for approximately 15 minutes. If H₂ fuel jet is misaligned, ensure the previous metal flame arrestor is properly seated.</p> <p>Adjust by screwing Mixer/Burner Assembly in or out. This spacing problem should only occur after reassembling a Mixer/Burner Assembly to a Preamp Assembly.</p>
3) H ₂ flame lights but will not stay lighted	<p>a) Follow procedures 2 (a), (c), (d), (e), (g) and (h) above. Also refer to 5 below.</p>	
4) Flame-out alarm will not go on when H ₂ flame is out	<p>a) Check instrument calibration setting and GAS SELECT control setting. Refer to paragraphs 2.3.1.2 and 2.3.2.</p> <p>b) Remove exhaust port and check for leakage current path in chamber (probably moisture or dirt in chamber).</p> <p>c) If above procedures do not resolve the problem, the probable cause is a malfunction in the preamp or power board assemblies.</p> <p>d) Check volume control knob is turned up.</p>	<p>Readjust as required to proper setting. Note that on linear OVA's the flame-out alarm is activated when the meter reading goes below zero. On logarithmic OVA's, the alarm is activated when the signal level goes below 1 ppm methane or equivalent.</p> <p>Clean contamination and/or moisture from the chamber using a swab and alcohol, dry chamber by running pump for approximately 15 minutes.</p> <p>Return preamp chamber or power board assembly to the factory for repair.</p> <p>Adjust for desired volume.</p>
5) False flame-out alarm. (Applies to linear OVA's)	<p>a) Flame-out alarm is activated on linear instruments when signal goes below electronic zero (even though flame is still on). This can be due to inaccurate initial setting, drift or a decrease in ambient concentration. Verify if this is the problem by zeroing meter with flame out and relighting. (See paragraph 2.3.2)</p>	<p>When using the XI range, adjust meter to 1 ppm rather than zero. See paragraph 2.3.2. Be sure instrument has been zeroed to "lowest expected ambient background level".</p>
6) Slow response time, i.e., time to obtain response after sample is applied to input. (Refer to paragraph 6.2.4)	<p>a) Check to ensure that probe is firmly seated on the rubber seal in the readout assembly.</p> <p>b) Check sample flow rate per procedure 1 above.</p>	<p>Reseal by holding the probe firmly against the rubber seal and then lock in position with the knurled locking nut.</p> <p>See 1 above.</p>

<p>7) Slow recovery time, i.e., too long a time for the reading to get back to ambient after exposure to a high concentration of organic vapor.</p>	<p>a) This problem is normally caused by contamination in the sample input line, requiring pumping for a long period to get the system clean of vapors again. Charcoal in the lines would be the worst type of contamination. Isolate through the process of elimination. (See 1 (b)).</p> <p>b) Check flame chamber for contamination.</p>	<p>Clean or replace contaminated sample line or assembly as required.</p> <p>Clean as required.</p>
<p>8) Ambient background reading in clean environment is too high. (Refer to paragraph 6.2.3)</p>	<p>a) An ambient background reading can be caused by hydrocarbons in the M2 fuel supply system. Place finger over sample probe tube restricting sample flow and if meter indication does not go down significantly the contamination is probably in the M2 fuel.</p> <p>b) An ambient background reading can be caused by a residue of sample, building up on the face of the sample inlet filter. If the test in 8 (a) above produces a large drop in reading, this is usually the cause.</p> <p>c) An ambient background reading can also be caused by hydrocarbon contamination in the sample input system. The most likely cause would be a contaminant absorbed or condensed in the sample line. Note: It should be emphasized that running the instrument tends to keep down the buildup of background vapors. Therefore, run the unit whenever possible and store it with the carrying case open in clean air.</p>	<p>Use a higher grade of hydrocarbon free hydrogen. Check for contaminated fittings on fitting nose assembly.</p> <p>Remove the exhaust port (it is not necessary to remove instrument from case). Use small wire brush from the tool kit or a knife blade and lightly scrub surface of sample inlet filter.</p> <p>Clean and/or replace the sample input lines. Normally the lines will clear up with sufficient running.</p>
<p>9) Pump will not run</p>	<p>a) Check 1 AMP Slo-Blo fuse on the battery pack cover. NOTE: Certified OVA's do not have fuses.</p>	<p>Replace fuse. IMPORTANT: Note that fuse is a Slo-Blo type. If fuse continues to blow when igniter switch is closed, check igniter for short circuit. If igniter is not the problem, there is a short in the wiring or pump motor. Return OVA to factory or authorized repair facility.</p>
<p>10) No power to electronics but pump runs</p>	<p>a) Check 1/4 AMP fuse on the battery pack cover. NOTE: Certified OVA's do not have fuses.</p>	<p>Replace fuse. If fuse continues to blow, there is a short in the electronics assembly. Return OVA to factory or authorized repair facility.</p>
<p>11) No power to pump or electronics.</p>	<p>a) Place battery on charger and see if power is then available. Recharge in a non-hazardous area only.</p>	<p>If power is available, battery pack is dead or open. Recharge battery pack. If still defective, replace battery pack. Reference paragraph 2.7.</p>

APPENDIX K

DOCUMENT CONTROL AND THE EVIDENTIARY FILE SYSTEM

DOCUMENT CONTROL AND THE EVIDENTIARY FILE
SYSTEM FOR FADROWSKI DRUM DISPOSAL RI/FS

ACCOUNTABLE DOCUMENTS

Accountable documents will include all logbooks, field data records, correspondence, sample tags, graphs, chain-of-custody records, and other sample documentaiton forms used, original dat including laboratory bench sheets, photographic prints and planning documents.

FILE STRUCTURE

Documents will be arranged in the evidentiary file using the format specified in Table 1 (attached).

LOGGING OF DOCUMENTS

Documents will be received by the Document Control Officer who will log them and assign a number to each such that documents within each document subclass are separately serialized. An exception to this will be items such as sample tags, chain-of-custody forms or other documents that are numbered prior to assignment for use.

DOCUMENT ACCESS

Project documents will be secured in a separate, locked file cabinet. Access will be limited by the Document Control Officer to project personnel. A check-out log will be maintained as a record of access.

EVIDENCE FILE AUDIT

Upon project completion, the Warzyn Quality Assurance/Quality Control Coordinator will audit the evidence file for completeness. Results of the audit will be documented on the attached form and kept in the Final Evidence file.

FINAL DISPOSITION OF FILE CONTENTS

The Final Evidence file will be maintained by Warzyn until issuance of the record of decision (ROD) at a minimum.

TABLE 1
DOCUMENT CLASSES AND STRUCTURE
FOR SUPERFUND EVIDENTIARY FILES

<u>Document</u>	<u>File</u>	<u>Contents</u>
File Index		Check out logs and list of active files
Contracts/ Proposals/Bids	A	Proposals, contracts, purchase orders, specifications - COPIES ONLY
Financial	B	Summary of invoice status; invoices correspondence re: accounts receivable; copy of budget and project task setup; COPIES ONLY
Correspondence	C	<p>Various incoming and outgoing letters, memorandums, diary notes</p> <p>C1-In-house correspondence; diary notes and memos</p> <p>C2-Outgoing lettes/memos</p> <p>C3-Incoming correspondence</p> <p>C4-Correspondence logged</p>
Work Plan Documents	D	Documents other than proposals; including Health and Safety plans, Sampling plans, QAPPs, permit plans; special instructions/outlines for conducting the project; Work Plans; WEI plans and specifications

QA File

E

QA Work Plan and budget;
project history file;
sample documentation
records, etc.

E1 Sample tags

E2-Chain-of Custody
Records

E3-Receipt of Samples
forms

E4-Transfer of Samples
forms

Field Data

F

Original field
data/notebooks

F1-Field boring logs

F2-Well construction
details

F3-Geotechnical testing

F4-Geophysical testing

F5-Water Quality testing

F6-Daily field logs

F7-Baildown testing

F8-Structural testing

F9-Miscellaneous/Other

Laboratory Data

G

Laboratory test data,
including original
analytical logbooks, lab
data, calculations, bench
records, graphs, etc. for
original data and quality
control data

G1-Analytical laboratory
data

G2-Geotechnical
laboratory data

G3-Materials testing
laboratory data

		G4-Subcontracted laboratory data
Calculations	H	Calculations, quantity estimates, computer printouts of tabularized data
Photographs	I	Photographs, stereo pairs, site maps (published zoning, topography, geology, groundwater, bedrock, negatives)
Originals	J	Warzyn original reports or drafts
Warzyn Reports	K	Copies of the project report or previous pertinent WEI reports
Warzyn Drawings	L	Reference list of report drawings; copies or reduced copies of original drawings. Note: original or reduced mylars will be stored separately
Other Reports/Drawings	M	Non-Warzyn reports and drawings including literature, reference, etc.
Miscellaneous	N	Other file information which does not fit into other categories; file must be named
Checkprint	O	TEMPORARY FILE of checkprints, draft reports or other work in progress. File must be removed upon job completion.

DOCUMENT AUDIT CHECKLIST*

PROJECT NO. _____

DATE OF AUDIT _____

PROJECT LOCATION _____

SIGNATURE OF AUDITOR _____

FILE LOCATION _____

Yes__ No__

1. Have individual files been assembled (field investigation, laboratory, other)?

Comments: _____

Yes__ No__

2. Is each file inventoried?

Comments: _____

Yes__ No__

3. Is there a list of accountable documents?

Comments: _____

Yes__ No__

4. Are all accountable documents present or accounted for?

Comments: _____

* From NEIC Procedure Manual for the Evidence Audit of Enforcement Investigations by Contractor Evidence Audit Teams, EPA-300/9-81-003-R, April, 1984.

Yes__ No__

5. Is a document numbering system used?

Comments: _____

Yes__ No__

6. Has each document been assigned a document control number?

Comments: _____

Yes__ No__

7. Are all documents listed on the inventory accounted for?

Comments: _____

Yes__ No__

8. Are there any documents in the file which are not on the inventory?

Comments: _____

Yes__ No__

9. Is the file stored in a secure area?

Comments: _____

Yes__ No__

10. Are there any project documents which have been declared confidential?

Comments: _____

Yes__ No__

11. Are confidential documents stored in a secure area separate from other project documents?

Comments: _____

Yes__ No__

12. Is access to confidential files restricted?

Comments: _____

Yes__ No__

13. Have confidential documents been marked or stamped "Confidential"?

Comments: _____

Yes__ No__

14. Is confidential information inventoried?

Comments: _____

Yes__ No__

15. Is confidential information numbered for document control?

Comments: _____

Yes__ No__

16. Have any documents been claimed confidential under TSCA?

Comments: _____

[jap-800-64a]

APPENDIX L

**INTERNAL CHAIN-OF-CUSTODY PROCEDURES FOR
COMPUCHEM, HAZLETON, AND WARZYN LABORATORIES**

-OFFICIAL COPY-
DO NOT DUPLICATE
Hazleton Laboratories
America, Inc.
Quality Assurance Unit

DEPARTMENT OPERATING PROCEDURE
CONFIDENTIAL
TRADE SECRET
HAZLETON LABORATORIES
AMERICA, INC.
DO NOT DUPLICATE

OP-PROJ. 1
PAGE 1 OF 2
DATE: 2/11/87
REPLACES: 4/21/86

PROCEDURE IDENTIFICATION: EPA WA-82-A155 Hazardous Waste Analysis

PROCEDURE TITLE: Chain of Custody Procedures

AREA OF APPLICABILITY: Hazleton Laboratories America, Inc.
Environmental Analysis

PURPOSE:

Future legal proceedings may necessitate Hazleton Laboratories America, Inc. (HLA) to produce documentation that traces the custody of samples from receipt through completion of analysis. In lieu of this, it is necessary for HLA to guarantee the continuous custody of samples by either the sample custodian or the lab analyst.

PROCEDURE:

The following procedures for documentation of chain of custody for samples received under Contract WA-82-A155 will be followed in addition to or as an addendum to those previously stated under OP-DIV 7 and OP-PROJ 2.

1. All samples will be stored locked in refrigerators located on the third and fourth floors. A list of sample numbers, arranged by EPA case number, will be maintained by the sample custodian.
 - 1.1 All bottles received for extractable compounds (semivolatiles or pesticides) will be stored at 4°C in one of two double-door refrigerators located on 3 South in Room 301.
 - 1.2 All bottles received for volatile analysis will be stored at 4°C on 4 South in the Mass Spectrometry area, in the refrigerator designated for volatile samples only.
2. Only the designated sample custodian and supervisory personnel will have keys to the double-door refrigerators.
3. Samples will remain in the designated refrigerators until removed for sample preparation and/or analysis.
4. All transfers of samples into or out of the double door refrigerators will be documented on an internal chain of custody record (see attached). These records are maintained by the sample custodian.
5. Once a sample is removed from a refrigerator by the analyst, he/she is responsible for the custody of the sample. Each analyst must return samples to the double door refrigerator before the end of the working day. Samples are not allowed to sit on the bench over the evening.

-OFFICIAL COPY-
DO NOT DUPLICATE
Hazleton Laboratories
America, Inc.
Quality Assurance Unit

**CONFIDENTIAL
TRADE SECRET
HAZLETON LABORATORIES
AMERICA, INC.
DO NOT DUPLICATE**

OP-PROJ. 1
PAGE 2 OF 2
DATE: 2/11/87
REPLACES: 4/21/86

APPROVED BY:

Mark A. Wirtz
Mark Wirtz
Environmental Analysis

DATE 2-11-87

David C. Hills
David Hills
Project Leader

DATE 2-11-87

REVIEWED BY:

Debra Curley Arndt
Debra Curley Arndt
Manager, Quality Assurance Unit

DATE 2/11/87

(1458E)

CONFIDENTIAL
TRADE SECRET
HAZLETON LABORATORIES
AMERICA, INC.
DO NOT DUPLICATE
EPA WA-82-A155 HAZARDOUS WASTE ANALYSIS
Chain of Custody

OP-PROJ. 1
ATTACHMENT

EPA WA-82-A155 HAZARDOUS WASTE ANALYSIS
Chain of Custody

Storage Location _____
Storage Date _____

[illegible]

-OFFICIAL COPY-
DO NOT DUPLICATE
Hazleton Laboratories
America, Inc.
Quality Assurance Unit

CONFIDENTIAL
TRADE SECRET
HAZLETON LABORATORIES
AMERICA, INC.
DO NOT DUPLICATE

OP-PROJ. 1
ATTACHMENT

PROJECT IDENTIFICATION: EPA WA-82-A155 Hazardous Waste Analysis

PROCEDURE TITLE: Chain of Custody Procedures

DISTRIBUTION:

<u>Name</u>	<u>Title</u>	<u>Department/Cost Center No.</u>
David C. Hills	Section Supervisor	Environmental Analysis/6004
Mark Wirtz	Documentation Custodian/ Sample Custodian	Environmental Analysis/6004

-OFFICIAL COPY-
DO NOT DUPLICATE
Hazleton Laboratories
America, Inc.
Quality Assurance Unit

DEPARTMENT OPERATING PROCEDURE
CONFIDENTIAL
TRADE SECRET
HAZLETON LABORATORIES
AMERICA, INC.
DO NOT DUPLICATE

OP-PROJ. 2
PAGE 1 OF 3
DATE: 2/11/87
REPLACES: 4/21/86

PROCEDURE IDENTIFICATION: EPA WA-82-A155 Hazardous Waste Analysis

PROCEDURE TITLE: Sample Receipt and Sample Logging Procedures

AREA OF APPLICABILITY: Hazleton Laboratories America, Inc.
Environmental Analysis

DISTRIBUTION:

See attached list.

PURPOSE:

These procedures are to be used in conjunction with the aforementioned project because of the nature of the samples and the special chain of custody procedures required.

SAFETY PRECAUTIONS:

All samples received under this contract should be considered hazardous and appropriate precautions should be taken when handling these samples. Upon initial receipt at Hazleton Laboratories America, Inc. (HLA) facilities, sample coolers should be inspected for any damage or leakage. Under no circumstances should any personnel other than the sample custodian or project leader open coolers. If damage or leakage is noted, stay clear of the coolers and notify the sample custodian or project leader immediately.

PROCEDURE:

1. The project leader will notify the sample custodian in writing of incoming samples.
2. When samples arrive at HLA, the shipping and receiving clerk or the receptionist will notify the sample custodian. The custodian will collect the samples and deliver them to a hood located on 3 South. The following procedures will be done by the sample custodian.
3. Examine the shipping container and record the following information in the project log book (one container per form).
 - 3.1 The presence/absence of custody seal on the shipping container.
 - 3.2 The condition of the custody seal (i.e., intact, broken).

-OFFICIAL COPY-
DO NOT DUPLICATE
Hazleton Laboratories
America, Inc.
Quality Assurance Unit

**CONFIDENTIAL
TRADE SECRET
HAZLETON LABORATORIES
AMERICA, INC.
DO NOT DUPLICATE**

OP-PROJ. 2
PAGE 2 OF 3
DATE: 2/11/87
REPLACES: 4/21/86

4. Open the shipping container in a well ventilated hood, remove the enclosed sample documents, and record the following information in the log book.
 - 4.1 The presence/absence of the chain of custody record(s).
 - 4.2 The presence/absence of Sample Management Office (SMO) forms (Traffic Reports, Chronicles).
 - 4.3 The presence/absence of airbills and/or bills of lading documenting shipment of the samples.
5. Remove the samples from the container and record the following information in the log book.
 - 5.1 Condition of samples (intact, broken, leaking, etc). Any broken and/or leaking samples should be carefully repacked, labeled as a Biohazard, and returned to the sponsor. The project leader should be notified and will contact the EPA project officer that the sample was received broken and returned.
 - 5.2 The presence/absence of sample tags.
 - 5.3 Sample tag numbers.
6. Compare the following documents to verify agreement of the information contained on them.
 - 6.1 Chain of custody records.
 - 6.2 Sample tags.
 - 6.3 SMO forms.
 - 6.4 Airbills or bills of lading.

Document agreement and/or any discrepancies found. If discrepancies are found, contact the SMO for clarification and notify the appropriate laboratory personnel.
7. If there are no problems with the sample shipment, sign the chain of custody record in the "Received for laboratory by:" box on the document. If problems are noted, sign for shipment and note problems in the "Remarks" box or reference other forms detailing the problems.

-OFFICIAL COPY-
DO NOT DUPLICATE
Hazleton Laboratories
America, Inc.
Quality Assurance Unit

**CONFIDENTIAL
TRADE SECRET
HAZLETON LABORATORIES
AMERICA, INC.
DO NOT DUPLICATE**

OP-PROJ. 2
PAGE 3 OF 3
DATE: 2/11/87
REPLACES: 4/21/86

8. Log-In the Samples.

8.1 Figure 1 is an example of a type of form the sample custodian could use in order to log-in samples and to record the information previously described.

9. Send preprocessing request form to Sample Entry requesting that HLA numbers be assigned to the samples, and that they be logged onto the LIMS under the appropriate mnemonic for tracking and billing.

9.1 The following LIMS mnemonics will be used for this contract:

HGMS Hazardous Waste GCMS Analysis
EPAP - Priority Pool Pesticides

9.2 Upon receipt of sample HLA numbers, log these HLA numbers into the book.

10. Sample Storage.

10.1 All bottles received for extractable compounds (semivolatiles or pesticides) will be stored at 4°C in one of two double-door refrigerators located on 3 South in Room 301.

10.2 All bottles received for volatile analysis will be stored at 4°C on 4 South in the Mass Spectrometry area, in the refrigerator designated for volatile samples only. At the time of storage a storage blank will be prepared identified with the case number and date prepared. This blank will be analyzed with those samples stored on the designated date to monitor the potential for cross-contamination of samples during storage.

APPROVED BY:

Mark A. Wirtz
Mark Wirtz
Environmental Analysis

DATE 2-11-87

David C. (Skill)
David Hills
Project Leader

DATE 2-11-87

REVIEWED BY:

Debra Curley Arndt
Debra Curley Arndt
Manager, Quality Assurance Unit

DATE 2/11/87

(1459E)

DATE:

INDIAN SIGNATURE:

OP-PROJ. 2-
ATTACHMENT

INCIDENT COMMAND

1. SELECT THE APPROPRIATE RESPONSE

Custody Seal

present/absent
intact/not intact

Chain-of-Custody

present/absent

Sample Tags

present/absent

Sample Tag Numbers

Item	Location	Quantity	Notes
1. 1000	1000	1000	1000
2. 1000	1000	1000	1000
3. 1000	1000	1000	1000
4. 1000	1000	1000	1000
5. 1000	1000	1000	1000
6. 1000	1000	1000	1000
7. 1000	1000	1000	1000
8. 1000	1000	1000	1000
9. 1000	1000	1000	1000
10. 1000	1000	1000	1000
11. 1000	1000	1000	1000
12. 1000	1000	1000	1000
13. 1000	1000	1000	1000
14. 1000	1000	1000	1000
15. 1000	1000	1000	1000
16. 1000	1000	1000	1000
17. 1000	1000	1000	1000
18. 1000	1000	1000	1000
19. 1000	1000	1000	1000
20. 1000	1000	1000	1000
21. 1000	1000	1000	1000
22. 1000	1000	1000	1000
23. 1000	1000	1000	1000
24. 1000	1000	1000	1000
25. 1000	1000	1000	1000
26. 1000	1000	1000	1000
27. 1000	1000	1000	1000
28. 1000	1000	1000	1000
29. 1000	1000	1000	1000
30. 1000	1000	1000	1000
31. 1000	1000	1000	1000
32. 1000	1000	1000	1000
33. 1000	1000	1000	1000
34. 1000	1000	1000	1000
35. 1000	1000	1000	1000
36. 1000	1000	1000	1000
37. 1000	1000	1000	1000
38. 1000	1000	1000	1000
39. 1000	1000	1000	1000
40. 1000	1000	1000	1000
41. 1000	1000	1000	1000
42. 1000	1000	1000	1000
43. 1000	1000	1000	1000
44. 1000	1000	1000	1000
45. 1000	1000	1000	1000
46. 1000	1000	1000	1000
47. 1000	1000	1000	1000
48. 1000	1000	1000	1000
49. 1000	1000	1000	1000
50. 1000	1000	1000	1000
51. 1000	1000	1000	1000
52. 1000	1000	1000	1000
53. 1000	1000	1000	1000
54. 1000	1000	1000	1000
55. 1000	1000	1000	1000
56. 1000	1000	1000	1000
57. 1000	1000	1000	1000
58. 1000	1000	1000	1000
59. 1000	1000	1000	1000
60. 1000	1000	1000	1000
61. 1000	1000	1000	1000
62. 1000	1000	1000	1000
63. 1000	1000	1000	1000
64. 1000	1000	1000	1000
65. 1000	1000	1000	1000
66. 1000	1000	1000	1000
67. 1000	1000	1000	1000
68. 1000	1000	1000	1000
69. 1000	1000	1000	1000
70. 1000	1000	1000	1000
71. 1000	1000	1000	1000
72. 1000	1000	1000	1000
73. 1000	1000	1000	1000
74. 1000	1000	1000	1000
75. 1000	1000	1000	1000
76. 1000	1000	1000	1000
77. 1000	1000	1000	1000
78. 1000	1000	1000	1000
79. 1000	1000	1000	1000
80. 1000	1000		

SHO Forms

present/absent

CASE NUMBER

APRIL 1946

-OFFICIAL COPY-
DO NOT DUPLICATE
Hazleton Laboratories
America, Inc.
Quality Assurance Unit

[illegible]

-OFFICIAL COPY-
DO NOT DUPLICATE
Hazleton Laboratories
America, Inc.
Quality Assurance Unit

CONFIDENTIAL
TRADE SECRET
HAZLETON LABORATORIES
AMERICA, INC.
~~PROJECT SPECIFIC SOP DISTRIBUTION~~
~~DO NOT DUPLICATE~~

OP-PROJ. 2
ATTACHMENT

PROJECT IDENTIFICATION: EPA WA-82-A155 Hazardous Waste Analysis

PROCEDURE TITLE: Sample Receipt and Sample Logging Procedures

DISTRIBUTION:

<u>Name</u>	<u>Title</u>	<u>Department/Cost Center No.</u>
David C. Hills	Project Leader	Environmental Analysis/6004
William Hamilton	Manager	Facility Services/6080
Paul Jacoby	Section Supervisor	Shipping and Receiving/6075
Judy Santos	Section Supervisor	Sample Entry/6099
Diane Loram	Manager	General Services/6072 (Building Receptionist)
Mark Wirtz	Documentation Custodian/ Sample Custodian	Environmental Analysis/6004

DEPARTMENT OPERATING PROCEDURE

OFFICIAL COPY-
DO NOT DUPLICATE
Hazleton Laboratories
America, Inc.
Quality Assurance Unit

**CONFIDENTIAL
TRADE SECRET
HAZLETON LABORATORIES
AMERICA, INC.
DO NOT DUPLICATE**

OP-PROJ. 3
PAGE 1 OF 3
DATE: 4/21/86
REPLACES: 1/3/83

PROJECT IDENTIFICATION:

EPA WA-82-A155 Hazardous Waste Analysis

PROCEDURE TITLE:

Duties and Responsibilities of the Documentation
Custodian and Procedures for Data Assembly and
Filing

AREA OF APPLICABILITY:

Hazleton Laboratories America, Inc.
Environmental Analysis

DISTRIBUTION:

See attached list.

PURPOSE:

To specify the duties and procedures of the documentation custodian for the
above-mentioned contract.

PROCEDURE:

1. The documentation custodian will organize and assemble all documents
relating to each EPA case.
2. This procedure will ensure that all documents to be submitted to EPA are
compiled in one location, preferably in single case files arranged by SMO
sample number.
 - 2.1 Prepare case file folders as follows:
 - 2.1.1 Assign one folder to each case according to SMO case number.
 - 2.1.2 Place all documents, sample tags, SMO forms, and laboratory-
generated data, pertaining to one case in the assigned folder.
 - 2.1.3 Arrange all documents by type within the case folders, i.e.,
all sample tags together, all Traffic Reports together, all
hardcopy Mass Spectra together, etc.
 - 2.1.4 File these document case files in one location in a secure
area.

-OFFICIAL COPY-
DO NOT DUPLICATE
Hazleton Laboratories
America, Inc.
Quality Assurance Unit

**CONFIDENTIAL
TRADE SECRET
HAZLETON LABORATORIES
AMERICA, INC.
DO NOT DUPLICATE**

OP-PROJ. 3
PAGE 2 OF 3
DATE: 4/21/86
REPLACES: 1/3/83

3. Document Numbering and Inventory Procedure.

3.1 Assignment of Accountable Numbers to laboratory-generated data.

- 3.1.1 Inventory each document of a case and assign it a serialized number (an identifier) associating it with a particular case. For example:**

SMO case = - serialized document folder
5081 01

- 3.1.2 Inventory and number all documents pertaining to each case including the following:**

- 3.1.2.1 Sample traffic records, weekly reports.**
- 3.1.2.2 Custody records, sample tags, airbills, internal custody records.**
- 3.1.2.3 Laboratory log books, personal log books, instrument log books, benchsheets.**
- 3.1.2.4 Laboratory data (sorted by sample), calibration and quality control results.**
- 3.1.2.5 Data summaries and reports.**
- 3.1.2.6 All other documents, forms, or records referencing the samples.**

3.2 Preparation of a Document Inventory.

- 3.2.1 Prepare a document inventory list to provide a record of all documents and their corresponding document numbers that are included in the completed case file.**
- 3.2.2 If documents for a case are sent to an EPA Region for enforcement action or other action, the laboratory will retain a copy of the document inventory list for that case.**

-OFFICIAL COPY-
DO NOT DUPLICATE
Hazleton Laboratories
America, Inc.
Quality Assurance Unit

**CONFIDENTIAL
TRADE SECRET
HAZLETON LABORATORIES
AMERICA, INC.
DO NOT DUPLICATE**

OP-PROJ. 3
PAGE 3 OF 3
DATE: 4/21/86
REPLACES: 1/3/83

APPROVED BY: Mark A. Wirtz
Mark Wirtz
Environmental Analysis

DATE 4-17-86

David C. Hills
David Hills
Project Leader

DATE 4-17-86

REVIEWED BY: Debra Curley Arndt
Debra Curley Arndt
Manager, Quality Assurance Unit

DATE 4/21/86

(0725E)

-OFFICIAL COPY-
DO NOT DUPLICATE
Hazleton Laboratories
America, Inc.
Quality Assurance Unit

CONFIDENTIAL
TRADE SECRET
HAZLETON LABORATORIES
~~AMERICAN INC.~~ LIST
DO NOT DUPLICATE

OP-PROJ. 3
ATTACHMENT

Document
Control Number

Number of Pages

File Inventory

Sample Tags

Sample Tracking Documents

EPA Chain of Custody

Airbills

Organic Traffic Reports

Extraction Worksheets/Screens

Copies of Analyst's Notebook Pages

Identification/Quantitation Worksheets

Copies of GC and GC-MS Operation Logs

Copies of Standard Preparation Log

Other Correspondence/Memos

QC Summary Package

Data Summary Package

Sample Data Package

Raw QC Data Package

Standard Package

Pesticide Raw Data

-OFFICIAL COPY-
DO NOT DUPLICATE
Hazleton Laboratories
America, Inc.
Quality Assurance Unit

**CONFIDENTIAL
TRADE SECRET
HAZLETON LABORATORIES
AMERICA, INC.**

OP-PROJ. 3
ATTACHMENT

~~DO NOT DUPLICATE~~ DISTRIBUTION

PROJECT IDENTIFICATION: EPA WA-82-A155 Hazardous Waste Analysis

PROCEDURE TITLE: Duties and Responsibilities of the Documentation
Custodian and Procedures for Data Assembly and
Filing

DISTRIBUTION:

<u>Name</u>	<u>Title</u>	<u>Department/Cost Center No.</u>
David Hills	Section Supervisor	Environmental Analysis/6004
Mark Wirtz	Documentation Custodian/ Sample Custodian	Environmental Analysis/6004

-OFFICIAL COPY-
DO NOT DUPLICATE
Hazleton Laboratories
America, Inc.
Quality Assurance Unit

CONFIDENTIAL
TRADE SECRET
HAZLETON LABORATORIES
AMERICA, INC.
DO NOT DUPLICATE

OP-PROJ. 4
PAGE 1 OF 2
DATE: 4/21/86
REPLACES: 1/3/83

PROJECT IDENTIFICATION: EPA WA-82-A155 Hazardous Waste Analysis
PROCEDURE TITLE: Duties and Responsibilities of the Sample Custodian
AREA OF APPLICABILITY: Hazleton Laboratories America, Inc.
Environmental Analysis

DISTRIBUTION:

See attached list.

PURPOSE:

To specify the duties of the sample custodian for the above-mentioned contract.

PROCEDURE:

Duties and responsibilities include:

1. Receiving samples (OP-PROJ 2).
2. Inspecting sample shipping containers for presence/absence and condition of:
 - 2.1 Custody seals, locks, "evidence tape", etc.
 - 2.2 Container breakage and/or container integrity.
3. Recording condition of both shipping containers and sample containers (bottles, jars, cans, etc.) in log books or on appropriate forms.
4. Signing appropriate documents shipped with samples (i.e., chain of custody record(s), SMO Traffic Reports, etc).
5. Verifying and recording agreement or non-agreement of information on sample documents (i.e., sample tags, chain of custody records, Traffic Reports, airbills, etc.) in log books or on appropriate forms. If there is non-agreement, record the problems, contact the SMO for direction, and notify appropriate laboratory personnel.

-OFFICIAL COPY-
DO NOT DUPLICATE
Hazleton Laboratories
America, Inc.
Quality Assurance Unit

**CONFIDENTIAL
TRADE SECRET
HAZLETON LABORATORIES,
AMERICA, INC.
DO NOT DUPLICATE**

OP-PROJ. 4
PAGE 2 OF 2
DATE: 4/21/86
REPLACES: 1/3/83

6. Initiating sample analysis procedures on appropriate laboratory documents or according to laboratory standard operating procedures including establishing case and sample files and inventory sheets.
7. Labeling samples with HLA sample numbers.
8. Securely storing samples, sample extracts, and spent samples.
9. Controlling access to stored samples and assuring that HLA standard operating procedures are followed when samples are removed from and returned to storage (see OP-PROJ 1).
10. Assuring that sample tags are removed from sample containers and are given to the laboratory personnel for inclusion in the sample case file. Missing tags are to be accounted for by putting a written memo into the sample case file. Information from the tags should be included in the memo, if available.
11. Monitoring storage conditions for proper sample preservation such as, refrigeration temperature and prevention of cross-contamination.
12. Returning shipping containers to the proper sampling teams.

APPROVED BY:

Mark A. Wirtz
Mark Wirtz
Environmental Analysis

DATE 4/17/86

David C. Hills
David Hills
Project Leader

DATE 4-17-86

REVIEWED BY:

Debra Curley Arndt
Debra Curley Arndt
Manager, Quality Assurance Unit

DATE 4/21/86

(0726E)

-OFFICIAL COPY-
DO NOT DUPLICATE
Hazleton Laboratories
America, Inc.
Quality Assurance Unit

**CONFIDENTIAL
TRADE SECRET
HAZLETON LABORATORIES
AMERICA, INC.**
~~DO NOT DUPLICATE~~

OP-PROJ. 4
ATTACHMENT

PROJECT IDENTIFICATION: EPA WA-82-A155 Hazardous Waste Analysis

PROCEDURE TITLE: Duties and Responsibilities of the Sample Custodian

DISTRIBUTION:

<u>Name</u>	<u>Title</u>	<u>Department/Cost Center No.</u>
David Hills	Section Supervisor	Environmental Analysis/6004
Mark Wirtz	Documentation Custodian/ Sample Custodian	Environmental Analysis/6004

DEVELOPMENT, REVIEW AND UPDATING
LABORATORY PROCEDURES

Scope and Application: To provide review, updates, development and implementation of laboratory procedures on a routine basis. Laboratory procedures are categorized as follows:

- SOP : Standard Operating Procedures
- IOP : Instrument Operating Procedures
- GLP : Good Laboratory Practices

References: Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, March, 1979, March, 1983 UPDATE.

Handbook for Analytical Quality Control in Water and Wastewater Laboratories, EPA, 1979.

Standards for Methods for Examination of Water and Wastewater, 16th Edition, 1985, APHA.

Test Methods for Evaluation Solid Waste, SW-846, 2nd Edition, July, 1982, Revised April, 1984.

Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, EPA 600/4-82-057, July, 1982.

Annual Book of ASTM Standards, "Water and Environmental Technology", Section 11, Parts 11.01-11.02, 1983.

Procedure:

1. On a semi-annual basis, the analytical laboratory QA/QC officer and laboratory supervisor will review all written SOP, IOP and GLP's and update them, as necessary, to include any changes stated in the updated authoritative sources. Additional SOP, IOP and GLP's will be developed as the need for them arises. The laboratory manager must approve any new or updated procedures prior to implementing them in the laboratory.
2. Following the index of each volume of operating procedures is a documentation record listing the laboratory personnel qualified to perform the task specified.

Michael J. Linskens
Michael J. Linskens
Laboratory Manager

Kim D. Finner
Kim D. Finner
Analytical Laboratory QA/QC Officer

Thomas J. Lynch
Thomas J. Lynch
QA Officer

Revision Date

Original 5/87 (5-21-87)

REPORTING RESULTS AND ARCHIVING DATA

Once data has been verified for accuracy and completeness by the laboratory manager, it is necessary to provide an accurate report to the client and a permanent laboratory record. Final data is submitted for typing and/or entry into the laboratory computer. When the draft report is printed, a final check against the original is performed by a second party. The final draft report is further reviewed by the laboratory manager and submitted to the laboratory director for approval. If approved the draft report is finalized for submittal to the client.

The laboratory manager receives the original and a copy of the final report. The original copy is filed in the Warzyn Company wide master job file. The copy is put with the raw and intermediate data set and filed by project number in the laboratory files.

Ongoing project data is entered for later use in the analytical laboratory computer. Quality control data is summarized and also entered into the computer. A summary of quality control results is provided to Warzyn management on a quarterly basis.

All raw and intermediate data are stored for a period of five years, when on a yearly basis they are disposed. Final reports stored in Warzyn master job file are kept for a twenty year period.

WET CHEMISTRY AND METALS DATA REVIEW

Scope and Application: This procedure is used to maintain uniformity throughout the laboratory in the area of data review. All calculations generated by the Warzyn laboratory are double checked.

Procedure:

A. Wet Chemistry and Metals Data Checking - Technician's Responsibility

1. Check header portion of the data sheet - this must be filled in completely and correctly:
 - Page numbered correctly
 - C#s recorded
 - Sampling dates/analysis date recorded
 - Sample handling correct
2. Review curve or standardization:
 - R2 should be 0.995 or greater for linear regression
 - Normality used should be reported to 3 decimal places
 - Intercept must be less than the detection limit! If not, the analytical run is re-analyzed.
3. For metal furnace ICP and Lachat methods, compare each raw number recorded on the bench sheet to the instrument print out. They must correlate.
 - Review the print out for labeling as follows:
 - Analyst's name
 - Date
 - Run #
 - Standardization clearly marked
4. Check each calculation. Watch for rounding and dilution errors!
5. Review continuing calibration standards - they must be within 90-110% of true value. (85-115% for mercury analysis). If not within acceptable range, notify group leader immediately.
6. Date and initial on line "Reviewed by: _____".
7. Hand in to appropriate group leader.

B. Wet Chemistry and Metals QC Check - Group Leader and Senior Technician

1. Review data sheets for complete and acceptable QC. Schedule repeat analysis if required.
 - Duplicates and spikes within control limits
 - Check run for continuing calibration standards and end of run check standard.
2. Weekly spot check the following items:
 - Check absorbance log book against a randomly chosen data sheet.
 - Check standard check book against a randomly chosen data sheet. (metals only).

C. Wet Chemistry and Metals Final Review - Supervisor's responsibility

1. Review for sign off on data and QC check.
2. Review QC for obvious technical problems.
3. Check data sheet for completeness.
4. Spot check dilution calculations.
5. Check for agreement of field duplicates.
6. Check for field blank contamination.
7. Review results for correct units. (Ex. mg/l vs. mg/kg).

Michael J. Linskens
Michael J. Linskens
Director, Technical Services

Revision Dates

8-18-88

Kim D. Finner
Kim D. Finner
Laboratory Manager

ORGANIC CHEMISTRY DATA REVIEW

SCOPE AND APPLICATION:

THIS PROCEDURE IS USED TO MAINTAIN UNIFORMITY THROUGHOUT THE LABORATORY IN THE AREA OF DATA REVIEW. ALL CALCULATIONS GENERATED BY THE WARZYN LABORATORY ARE DOUBLE CHECKED.

PROCEDURE:

A. ORGANIC CHEMISTRY DATA CHECKING - PEER REVIEW

1. CHECK THE HEADER PORTION OF THE DATA SHEETS - THIS MUST BE FILLED IN COMPLETELY AND CORRECTLY. THEN CHECK:
 - C# RECORDED
 - DATE ANALYZED
 - DATE EXTRACTED
 - LAB NOTEBOOK #/PAGE #
 - INSTRUMENT RUN #
2. REVIEW THE RAW DATA
 - CHECK THE CHROMATOGRAM FOR CORRECT IDENTIFICATION OF COMPOUNDS
 - CHECK FOR THE CORRECT TRANSCRIPTION OF PEAK HEIGHT OR AREA ONTO THE CALCULATION SHEET
 - ROUNDING HAS 3 SIGNIFICANT FIGURES
3. CHECK CALCULATIONS. WATCH FOR ROUNDING AND DILUTION ERRORS!
4. REVIEW CONTINUING CALIBRATION STANDARDS - THEY MUST BE WITHIN ACCEPTABLE LIMITS. IF NOT WITHIN ACCEPTABLE RANGE, NOTIFY GROUP LEADER IMMEDIATELY.
5. CHECK THAT DUPLICATES AND SPIKES ARE WITHIN ACCEPTABLE LIMITS.
6. CHECK THAT REPORTING UNITS ARE CORRECT.
7. REVIEW SURROGATE RECOVERY FORM AND MAKE NOTE OF SURROGATES OUTSIDE ACCEPTABLE LIMITS.
8. DATE AND INITIAL ON LINE "REVIEWED BY: _____".
9. HAND IN TO APPROPRIATE GROUP LEADER.

B. GROUP LEADER CHECK

1. REVIEW DATA SHEETS FOR COMPLETE AND ACCEPTABLE WORK. SCHEDULE REPEAT ANALYSIS IF REQUIRED.

2. UPDATE THE LIM'S SYSTEM.
3. WEEKLY SPOT CHECK THE FOLLOWING ITEMS:

- CALCULATIONS
- LAB NOTEBOOKS
- INSTRUMENT LOGBOOKS
- PEER REVIEW

C. FINAL REVIEW - SUPERVISOR'S RESPONSIBILITY

1. REVIEW FOR SIGN OFF ON DATA.
2. CHECK DATA SHEET FOR COMPLETENESS.
3. SPOT CHECK DILUTION CALCULATIONS.
4. CHECK FOR AGREEMENT OF FIELD DUPLICATES.
5. CHECK FOR FIELD BLANK CONTAMINATION.
6. REVIEW RESULTS FOR CORRECT UNITS. (EX. MG/L vs MG/KG).
7. REVIEW RESULTS AGAINST FIELD REQUEST.
8. SIGN OFF ON THE "APPROVED BY _____".

Review Date

9-21-88

Kim D. Finner

Kim D. Finner
Laboratory Manager

Michael J. Linskens

Michael J. Linskens
Director, Technical Services

(4)

(7)



OPERATING INSTRUCTIONS

Model GPK or GK

COMBINED OXYGEN/COMBUSTIBLES INDICATOR

INSTRUCTIONS 23-9081

OPERATION AND MAINTENANCE

J-W MODEL GPK AND GK OXYGEN/
COMBUSTIBLE GAS INDICATOR

7.0 CALIBRATION (COMBUSTIBLES SECTION)

The standard calibration using methane has been selected so that most commonly encountered gases and vapors as listed below and the more volatile lacquer and paint thinners, all indicate quite accurately or within reasonable error on the side of safety.

Gases	Vapors	
Natural Gas	Pentane	Benzene
Methane	Hexane	Ethyl Ether
Ethane	Heptane	Acetone
Propane	Methyl Alcohol	Ethyl Acetate
Butane	Ethyl Alcohol	
Carbon Monoxide		
Acetylene		

7.1 Checking Combustibles Calibration Using Known Gas Sample (See Figure 12)

It is often necessary, and even mandatory, to periodically check the instrument against a known, standard blend of calibration gas.

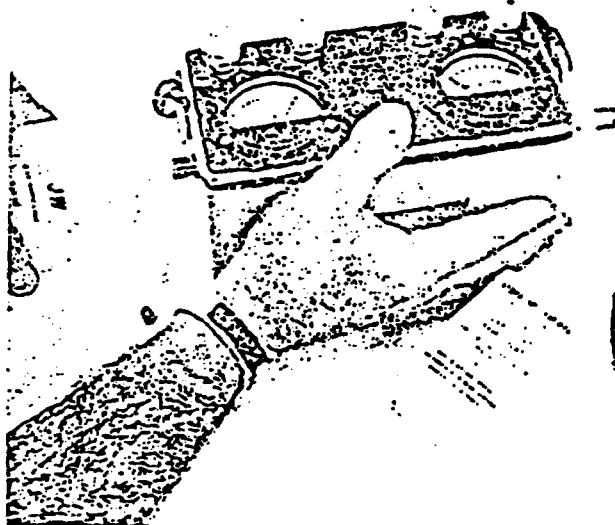


Figure 12 Inserting 1.1% methane gas sample into sample inlet.

The JAW 550-075 Gas Indicator Test Kit provides a convenient method for testing the instrument's response to a known gas concentration. Methane is used as a calibration gas because indicator response to methane is more critical than response to most other gases. If the indicator has normal response to methane it will respond normally to most other combustible gases and vapors. Contained in the Kit are gas-filled ampoules and a plastic squeeze bottle which will produce a known 1.1% by volume methane/air mixture, when one ampoule (brown color coded end) is shattered in the bottle. Use the following procedure to calibrate the instrument.

(a) Remove the screw spout and squeeze plastic bottle several times to purge residual gas from previous test.

(b) Drop one glass ampoule into the plastic squeeze bottle and replace the screw spout. Make certain that red end cap is firmly in place.

(c) Shake the bottle until the ampoule is shattered by the breakers in the bottle. With the instrument in normal operation but without sample probe and hose attached, remove the red end cap, grasp the bottle firmly in the left hand and force the nozzle into the sample inlet fitting on the left side of the instrument. Inject gas sample while keeping pressure on the bottle.

Do not depend upon the pump or use of the aspirator bulb to draw sample through the instrument as this will result in leakage and unintentional dilution.

(d) Observe that the combustible meter pointer deflects upscale. Record the maximum meter reading indicated. An acceptable reading is approximately .25 L.E.L. on the combustible meter scale. .20 L.E.L. or less is unacceptable and is cause for recalibration.

NOTE: If low reading is obtained the first time, repeat the test to insure that no dilution occurred.

(e) Refer to Figure 13a for location of the calibration adjustment potentiometer, which is accessible through the small hole in back of the case. Use a small screwdriver to turn the slotted shaft clockwise to increase reading. This is a 25 turn potentiometer, so several turns may be required to bring the meter reading to .25 L.E.L. while simultaneously squeezing the plastic bottle. After readjusting the calibration potentiometer, repeat 7.1 (c) again as a final check.

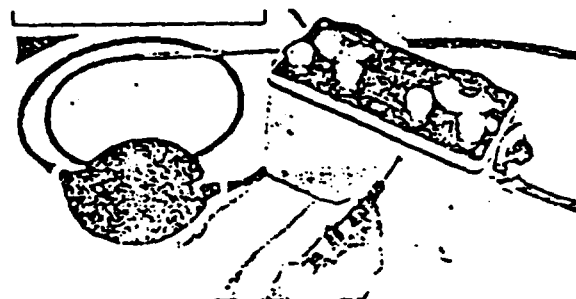


Figure 13a Adjusting Calibration Potentiometer

7.3 Testing Oxygen Cell for Calibration and Sensitivity

Operation of the instrument is normal if the meter can be set to read 21% on atmospheric air. A convenient test to prove response is to set the calibration to 21% and then blow slowly into the indicator inlet. As the lungs become exhausted the readings will go lower, a reduction to 15% being normal. With effort, the reading can be reduced as low as 10%.

To check performance near 0% oxygen, admit a small steady stream of oxygen free gas to inlet, such as nitrogen or natural gas. A cell in good condition will give a zero reading. A reading of 1% or more indicates need for reactivation.

8.0 MAINTENANCE SCHEDULE FOR MODELS GK AND GPK

DAILY:

The instrument should be checked for response before each day's operation as follows:

1. Check battery voltage reserve by observing whether voltage can be adjusted to at least 0.7 on the combustibles scale; then reset to green index arrow.
2. Check oxygen cell on fresh air and observe whether meter can be set to 21% O_2 .
3. Check combustibles response by placing a few drops of gasoline or lighter fluid on a cloth, and proceeding as in Section 5.1 Step (e). Observe that combustibles pointer deflects upscale (if a slight explosion is heard, no harm will be done). Avoid excessive use of fluid as it will be difficult to clear the instrument.
4. Test leak tightness of sample inlet system by closing off the inlet fitting with finger and listen for pump slowdown to occur (GPK). With Model GK, check for internal leaks by squeezing the aspirator bulb, placing the finger over the inlet fitting, and releasing the bulb. If the bulb springs back quickly, an internal leak is present that should be corrected before using the instrument.
5. Replace cotton filter in probe chamber if working in an extremely dirty environment.

WEEKLY: Test instrument response to a known concentration of methane in air as outlined in Section 7.1.

MONTHLY (or as required):

Check combustibles reaction chamber for accumulations of dirt or foreign material that may restrict free movement of gas sample.

EVERY SIX MONTHS (or as required):

Maintain Oxygen Cell as outlined in Section 8.1 Step (a) through (e).

8.1 Oxygen Cell-Maintenance (Refer to Figures 14 and 15)

The 514-010 Oxygen Cell requires periodic maintenance and reactivation.

The 514-011 Reactivation Kit is supplied for this purpose. There are two levels of cell maintenance, which are described below.

Both operations can be carried out with one kit, as an adequate supply of electrolyte solution (KCl) is provided to fill the cell at least twice.

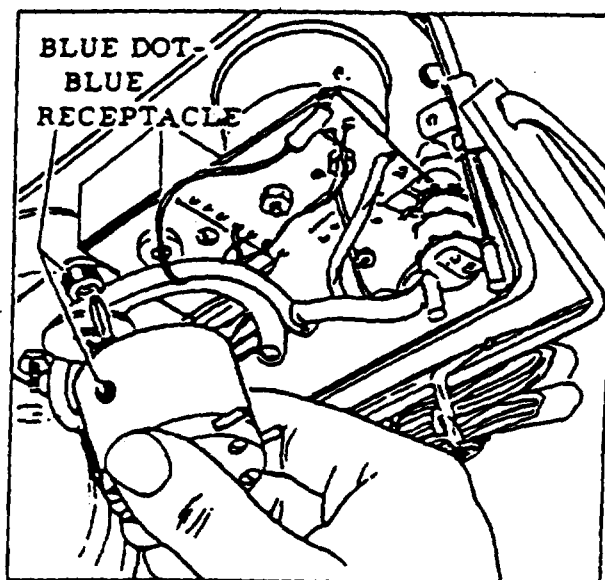


Figure 14: Correct method of connecting Oxygen Cell (note position of blue dot).

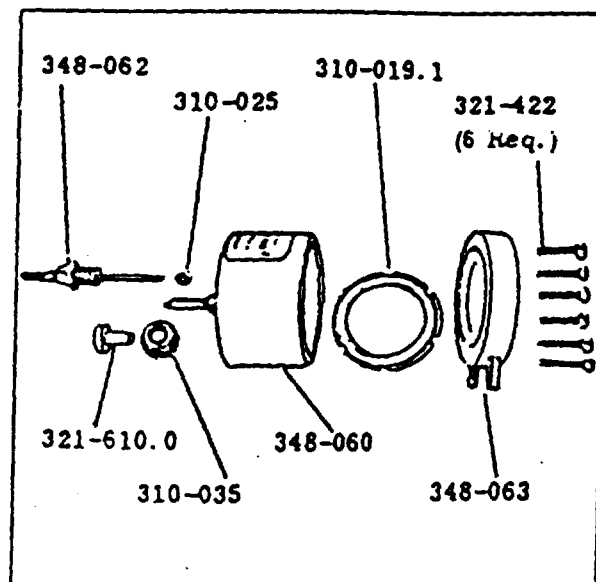


Figure 15: Parts identification for 514-010 Oxygen Cell.

8.1.1 Maintenance

The Oxygen Cell will usually operate up to 6 months without attention, but occasionally within this period, cell output may drop appreciably or change suddenly with sampling or sudden shock. To correct this condition, proceed with the following:

(a) Remove top panel from instrument case by loosening the two captive hold-down screws.

Unplug Oxygen Cell from the printed Circuit Board and disconnect the plastic tubing from the cell inlet and outlet nipples.

(b) Remove the nylon screw and seal ring on the electrical plug side of the cell. Refer to Figure 15 and unscrew the zinc electrode (banana plug nearest the blue dot on the side of cell) and remove it together with its O-Ring seal.

(c) Drain all the solution from the cell and completely fill with fresh KCl solution through either opening.

(d) Replace O-Ring on the zinc electrode, screw the electrode into the cell and tighten, using a small wrench. Install and retighten nylon screw with seal.

(e) Allow a few minutes for the cell to stabilize before attempting to make a reading.

NOTE: DO NOT WASH OR WIPE ELECTRODE AT ANY TIME.

8.1.2 Reactivation of Oxygen Cell (Refer to Figures 15, 16, 17)

In the event oxygen cell fails to function properly after changing solution as outlined in Section 8.1.1 or if it has been six months since solution was last changed, the cell may require reactivation. Reactivation Kit 514-011 is all that is required to completely reactivate the oxygen cell. The Kit contains a cap gasket with Teflon membrane, zinc electrode with O-ring, nylon screw with seal, KCl solution, nylon pad and brush.

To reactivate the cell, proceed as follows:

1. Remove nylon screw and seal and unscrew and remove zinc electrode and O-ring. Discard the zinc electrode, the screw, the O-ring and the seal.

2. Drain solution from cell.

3. Remove cap and gasket with membrane by removing the six screws which hold the cap in place. Discard the gasket with membrane.

4. Wash the cell thoroughly with cold, clean water. Use the brush to remove any white substance that may remain on the gold electrode. **DO NOT USE ANY SOAP OR DETERGENT.** If the white substance cannot be removed from

sive nylon pad can be used to remove it, but the gold electrode should be handled very carefully and only slight pressure applied in cleaning with the nylon pad. Wash again with brush and water.

5. Put one drop of KCl solution on top of the gold electrode and put new gasket with membrane in place. The side of the gasket with the Teflon membrane should face the gold electrode.

6. Replace the cap, observing the direction of the sampling nipples. Nipples should point away from the label on the cell body. Tighten all screws until the cap shoulder is flush with the cell body.

The cell is now dry charged and can be stored as long as desirable.

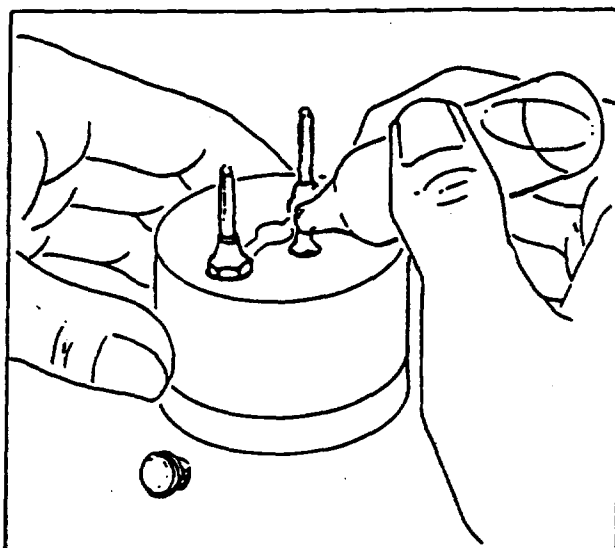
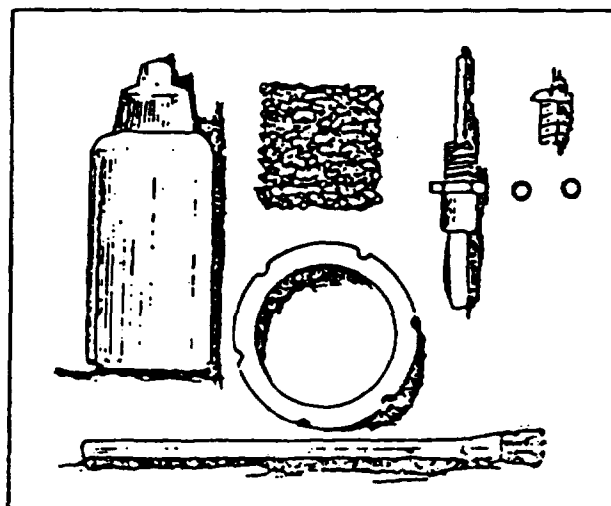


Figure 16: Activating cell with electrolyte (KCl solution)



To activate the cell:

1. Fill the cell with KCl solution, through either of the openings for the nylon screw or for the zinc electrode.
2. Check to see if the O-ring is still in the zinc electrode opening; if it is, remove it.
3. Be sure the new O-ring is in place on the zinc electrode, screw zinc electrode into cell and tighten with a small wrench.
4. Plug fill hole with nylon screw and new seal ring (310-035). The cell is now fully activated.

8.2 Oxygen Cell Contamination by Foreign Liquids

If any liquid has been accidentally introduced into the sampling line and thus into the sampling chamber of the cell, it will be necessary to flush the system out with distilled water as soon as possible. To do this, use the following procedure:

- (a) Disconnect the cell completely, remove, and pour distilled water into one sampling nipple until it comes out of the other. Drain water out and repeat this procedure several times.
- (b) Insert the cell into the P.C. Board, observing plug color coding. Reconnect sample tubing, one to the inlet and the other directly to sample pump or aspirator bulb (bypass the combustibles reaction chamber).
- (c) Turn "ON" the pump (Model GPK) and allow 5 minutes drying time for sampling chamber. For Model GK, stroke aspirator bulb about 50 times to insure cell chamber is thoroughly dried. The cell should now register normal output and is ready for use.
- (d) Reconnect sample tubing so that outlet of O₂ cell goes to reaction chamber, and outlet of reaction chamber goes to pump inlet (or aspirator bulb).

8.3 Maintenance of the Combustibles Section

Filaments and Flame Arrestor (Refer to Figure 18)

There are two separate filament units: (1) the active filament, which is installed in the flame arrestor, and is the unit that actually comes in contact with the gas being tested; and (2) the reference filament that helps balance the electrical circuit.

The reference filament should rarely require replacement inasmuch as it operates at a very low voltage and never comes in contact with the gas. Replacement may be necessary if the indicator has been dropped or severely damaged, or if the instrument has been in frequent use over many years.

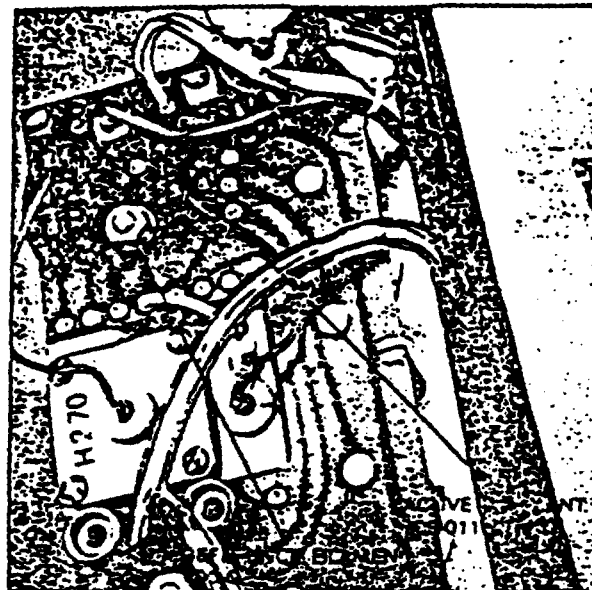


Figure 18: Active and reference filament locations.

The active filament should experience long life in ordinary service, probably on the order of a year or more, depending on frequency of use. The end of the useful life of the active filament is reached when it is no longer possible to bring the hand of the meter to "zero" with the zero adjustment. Another sign of trouble in the filament unit is when the meter pointer flies violently upscale with the instrument "ON," and zero adjustment is impossible. This usually means the active filament is burned out and must be replaced.

If the GK or GPK has been in use for a considerable period of time, or in moist or dusty conditions, it is frequently desirable to replace the filament flame arrestor assembly in combination. This is done by unplugging the O₂ cell, removing the four screws holding the brass plate to the underneath of the panel, and removing the filament lead from the subpanel terminal. When putting in a new filament flame arrestor assembly, make certain that the gasket is in place and compressed evenly by four screws.

When replacing the filament only, and reusing the flame arrestor, first remove and inspect the flame arrestor, checking for dust, corrosion or other damage. Replace gasket if it has deteriorated. Install new filament in place of old one, screwing it into the flame arrestor plate to compress the O-ring gasket as tightly as possible using the thumb and finger. When inserting filament be very careful not to touch or distort the platinum coil.

To replace the reference filament, first unsolder the black wire at subpanel, and unplug the O₂ cell. Then unscrew the knurled reference filament base from its cavity, using a pair of pliers. Install the new filament in the same position, tightening with pliers, and solder wire to subpanel.

NOTE: After replacement of either the active or reference filaments, perform the OPERATIONAL CHECK as outlined in Section 5.1. Steps (a) through (e).

Part numbers for filaments are:

800-007—Active Filament Flame Arrestor Assembly

800-011—Active Filament only (red wire)

800-022—Reference Filament only (black wire)

310-017—Flame Arrestor Gasket only

8.4 Battery Replacement and Charger Check (Refer to Figures 19, 20)

The most frequent form of maintenance will involve recharging the batteries as outlined in Section 5.3 and occasional burnishing of the silver contact buttons on the Printed Circuit Board with fine sandpaper (No. 400 or equivalent). The batteries can be recharged hundreds of times to render many years of useful service. Usually, the most probable cause of "apparent" battery failure can be traced to charger malfunction or contact problems. The batteries can only be charged with the instrument panel firmly in place. With the panel removed, the batteries can be inspected for deterioration by removing them from the storage compartment. When replacing batteries, be certain to reinstall them in the positions indicated on the side of the battery compartment.

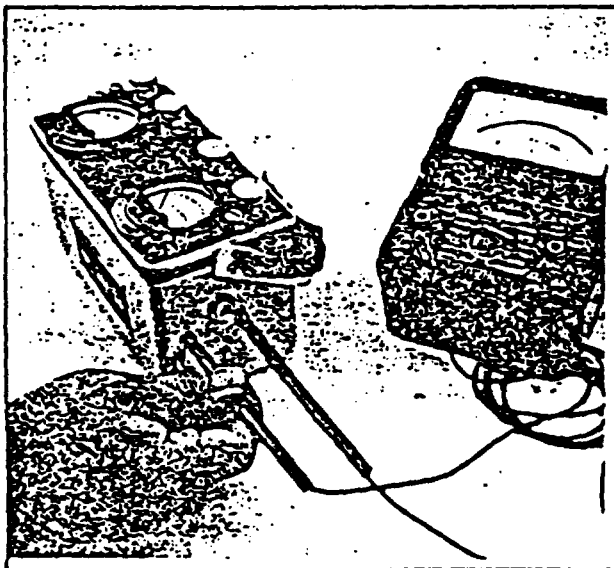


Figure 19: Checking power circuit for proper voltage (Section 8.4, Steps a and b)

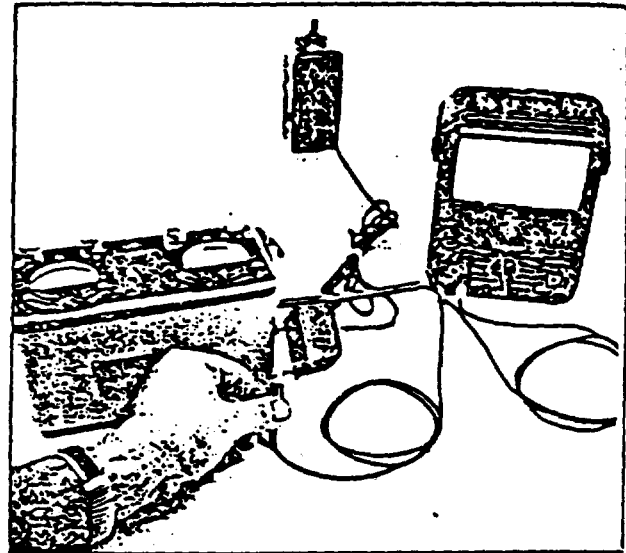


Figure 20: Measuring charge rate (Section 8.4, Step d).

NOTE: OBSERVE CORRECT POLARITY—INCORRECT BATTERY INSTALLATION CAN RESULT IN DAMAGE TO THE BATTERIES OR TO THE INSTRUMENT ITSELF. To insure that batteries are being recharged and that the Charger is functioning properly, perform the following check:

(a) Obtain a Multimeter and place the range selector on the 10 volt scale. Connect the meter test probes across the instrument charging jacks as illustrated in Figure 19. With the instrument FUNCTION CONTROL in the "OFF" position, the Multimeter should indicate 5 volts.

(b) Turn the FUNCTION CONTROL switch to the "ON" position and observe that battery voltage drops to 2.5 to 2.6 volts, then remove the meter probes. NOTE: Failure to obtain 2.5 volts indicates depleted batteries, open contact with subpanel buttons or open electrical connection. Correct malfunction before proceeding with the next step.

(c) Plug Charger line cord into 115 VAC outlet. Connect meter probes across charger pins and check output for approximately 5.5 volts (normal unloaded voltage).

(d) Now refer to Figure 20 and connect the Charger as shown with only the negative pin (—) connected to the black (—) charging jack. Place the Multimeter range selector to the 500 ma scale.

Connect the (+ red) positive meter probe to the remaining exposed pin on the Charger and the black (—) Multimeter probe to the red (+) charging jack of the GPK (GK) With Charger

connected to 115 VAC. Multimeter should indicate a charge rate of 120 to 150 ma (depending on battery state, line voltage, etc.) with the FUNCTION SWITCH in the "OFF" position. If Multimeter indicates "zero" ma, refer to Troubleshooting Section 8.9, Step 6.

(e) Now turn on the FUNCTION SWITCH to the "ON" position. Multimeter should indicate approximately 250 ma. (Never attempt to charge the batteries with the switch "ON," because the power consumption is greater than the Charger delivery rate.) If Multimeter indicates 300 ma or more, refer to Troubleshooting Section 8.9, Step 6.

NOTE: Failure to attain the above readings indicates a faulty Charger or Pump motor, open contact with subpanel buttons, or open electrical connection. If the correct indications are obtained, the circuit is normal and the batteries simply require recharging.

8.5 Testing Sample Flow Lines (Refer to Figure 17)

When installing the instrument panel in the bottom housing, take care not to pinch or obstruct the sample tubing. Always make certain that the sample tubing is placed in the cavity beside the battery compartment and arranged to prevent sharp bends or pinching when the panel is secured. For both Models GK and GPK, normal flow rate is approximately 2.5 liters per min. and response time to a combustible gas is approximately 5 seconds when short probe and 30" hose is used. Leaks or restrictions in the flow system will of course increase the response time.

A quick and simple check to determine the tightness of the sample system is to obstruct the flow at the probe tip or inlet fitting of the indicator. In the Model GPK the pump should slow or stop. If it does not, a leak in the pump or sample system is indicated. In the Model GK the aspirator bulb should be squeezed, released, and remain compressed for about 20 to 30 seconds. If the pump continues to operate normally or the bulb immediately springs back to its original form a leak exists which must be corrected before attempting to use the instrument.

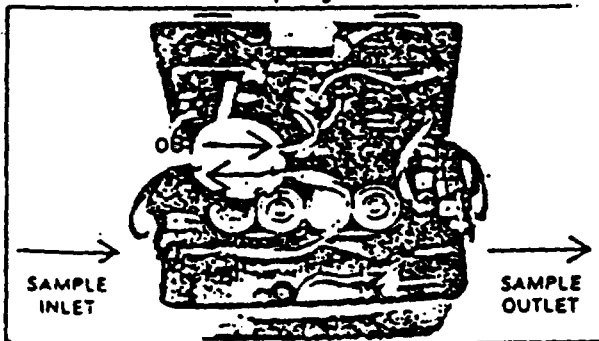


Figure 21: Sample tubing connections for all major components

8.6 GPK Sample Pump/Motor Replacement (Refer to Figure 18)

The GPK Sample Pump Assembly Code 342-626 is located adjacent to the outlet fitting in the Bottom housing.

To replace the Sample Pump Assembly, first remove the two screws from the outside of the lower case housing and release the pump assembly with mounting bracket. Mark the bracket "TOP" and "BOTTOM" for reference, then disconnect sample tubing. At the printed circuit board, unsolder the red and black leads to the pump motor and note the location for future reference.

With a 3/64" Allen wrench, loosen the set screw in the cam to free motor shaft, then remove the two screws from the motor mount.

Check valve action by sucking gently on the Inlet tubing connection and blowing gently into the outlet tubing connection. The valves should resist either test and stay firmly closed. If the valves pass the above test, only the pump motor will require replacement. If not, the complete Sample Pump Assembly Code 342-626 must be overhauled or replaced.

Install new motor Code 04-4053 and secure to pump mounting bracket. Reinstall pump assembly and bracket, solder pump connections to printed circuit board and connect tubing as illustrated in Figure 22A

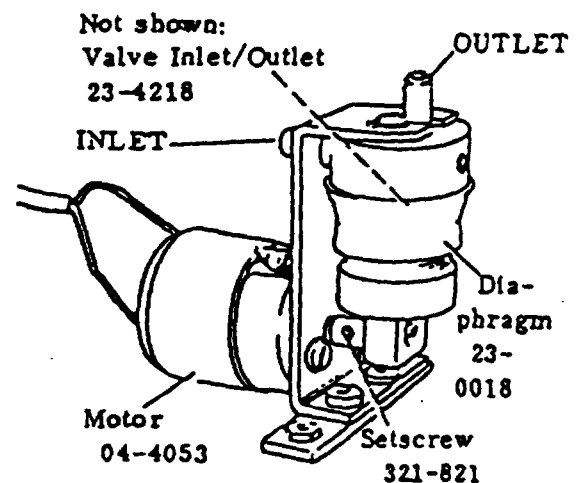


Figure 22: 342-626 Sample Pump with motor and mounting bracket. Inlet and Outlet tubing connections shown.

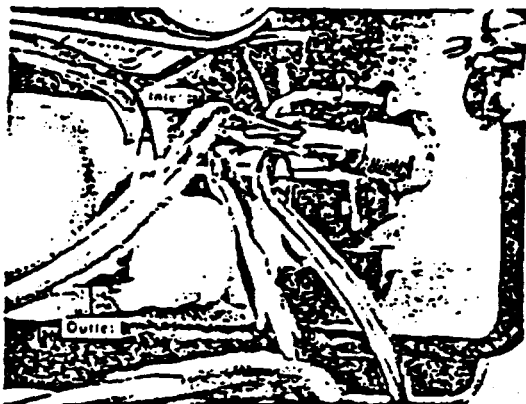


Figure 22A: Sample Pump Assy. properly installed

8.7 Meter Replacement

Meter trouble is usually indicated by erratic action, for instance, the indicator meter pointer will start to go up smoothly, pause momentarily at a reading, and then jump quickly over the next few divisions of the scale. Another sign of trouble is for a meter to be almost or entirely inactive, and to "stick" or show a permanent displacement of the pointer.

If the meter is giving trouble it may be removed by taking off the meter nuts and the meter hold down screws. Field repair of meters is generally inadvisable unless a qualified instrument repair facility is available.

PLEASE NOTE FOLLOWING BEFORE REPLACING METER:

The zero, calibrate and voltage adjuster knobs all turn an arm which runs back and forth over a resistance coil. To keep the sliding contact of the coil clean, it is good practice to turn the knobs back and forth three or four swings of the meter pointer each day as the instrument is first put into service.

8.8 Trouble Shooting Guide SEE CHART ON OPPOSITE PAGE.

9.0 ACCESSORIES FOR MODELS GK, GPK

9.1 Probes and Sampling Hoses

When Models GK and GPK are purchased complete with carrying case and accessories, a short aluminum probe with filter and 30" of Nylon lined hose are supplied as standard (Stock No. 550-015).

For special applications as noted below, longer probes in aluminum and fiberglass (nonconducting) and longer hose assemblies can be supplied. Various styles are available, and extension hoses can be provided for coupling between the hose and the instrument. The aluminum probe is generally used except where the nonconducting properties of fiberglass are required for the application. Nylon lined hose is particularly resistant to organic vapors, such as the aromatics like xylene.

The following hose and probe combinations with standard union fittings are available.

1. Fiberglass probe with dust filter chamber and 42" nylon lined hose (Stock No. 550-013). Used primarily by utility companies where an electrically non-conducting probe is desired and gases such as natural and manufactured gas are sampled.
2. Aluminum probe (long) with dust filter chamber and 42" nylon lined hose (Stock No. 550-014). Used in nearly all other applications. Probe of 3/8" diameter is very rugged and is perforated a few inches from the tip to prevent liquid from getting into the sampling hose should the probe be accidentally placed in liquid. The hose is unaffected by petroleum vapors.
3. Five foot hose. Stock No. 550-060 (nylon lined). Used as an extension hose. Can be used with either (1) or (2) above. Longer lengths of hose, complete with unions, are available in 5, 10, 15, 20, 25 and 50 foot lengths.
4. Dust filter chamber with fittings (Stock No. 550-025). Useful where just a filter chamber is required at the instrument inlet. Standard hose (550-060, or longer extensions) can be attached for remote sampling.

9.2 Sample Line Moisture Trap (See Figure 23)

#550-081 Sample Line Chamber. Although the cotton filter in the filter chamber of the probe tends to trap water or other liquids before they reach the instrument, it is normally a wise procedure to use a water trap if there is a continual problem with excessive moisture.

The 550-081 Sample Line Chamber is designed to act as a moisture trap when there is danger of drawing liquid or water into the instrument, or to help dry a sample when it is filled with calcium chloride or other drying agent. It can also be used as an additional dust filter trap where extremely dusty atmospheres are encountered.

The Sample Line Chamber comes complete with fittings, one end attaching to the GK or GPK sample inlet, and the other end to the sampling hose. The Chamber itself is a clear lucite tube. The capacity of the chamber is about 3 oz.



Figure 23: 550-081 Sample Line Chamber

APPENDIX N

FIELD MEASUREMENT OF PERMEABILITY USING THE BAILDOWN TEST

FIELD MEASUREMENT OF PERMEABILITY BAIL-DOWN TEST

INTRODUCTION

The objective is to determine hydraulic parameters (transmissivity, storativity, hydraulic conductivity) of the water-bearing strata. Single well aquifer tests are used because they may be conducted using a minimum of equipment, personnel, and time. They may also be done at many points within an aquifer and may be used to better plan a full-scale pumping test.

PROCEDURES

Each bail-down test is conducted by measuring the static water level with an electric water level indicator or cloth tape with attached sounding device, placing a pressure transducer (connected to a Hermit data logger¹), below the water level, and removing one bailer volume from the well. The recovery of the water level back to the static level is recorded over the necessary period of time, using a logarithmic sampling mode on the data logger.

The electric water level tape and transducer are wiped, first with methanol and then with deionized water as they are placed in the wells, to prevent cross-contamination between wells. The bailer is lowered with an attached 1/8-inch stainless steel cable. The bailer and cable are decontaminated between uses by washing and rinsing with Liquinox soap and water, rinsing three times with methanol, and rinsing three times with deionized water. The bailer and cable are then allowed to air-dry on steel supports and are covered with new sheet plastic.

DATA REDUCTION

The data accumulated during the bail-down tests are used to calculate hydraulic parameters using several published methods. Hydraulic conductivity is calculated for shallow unconfined wells using the Bouwer and Rice method (1976). The NAVFAC method (1971) is used for comparison. Transmissivities and storativities for the deeper, confined wells are determined using the curve matching method described by Cooper, et al. (1967). For comparison, hydraulic conductivities are also calculated using the Hvorslev method (1951). All methods assume an infinite, homogenous, isotropic aquifer and an instantaneous change in head in the well.

The method described by Bouwer and Rice (1976) is based upon modifications to the Thiem equation, with the use of an analog model. A straight line is drawn through a semi-log plot of relative head versus time, and the hydraulic conductivity is calculated using the slope of that line and the geometry of the well and aquifer. The formulation assumes that draw-down of the water table around the well is negligible, that flow in the

¹ Hermit Environmental Data Logger, Model SE1000B,
In-Situ, Inc., Laramie, Wyoming 82070.

capillary fringe may be ignored, and that well losses are negligible. It is applicable to completely or partially penetrating wells in unconfined aquifers, but may be used for confined aquifers that receive water from the upper confining layer.

In the NAVFAC method (1971), a straight line is also drawn through a semi-log plot of recovery data for unconfined aquifers. The method is based on the Hvorslev method. It assumes that the well is cased below the water table, and the ratio of the screen length to the well radius (L/R) is greater than eight.

The Cooper, et al. (1967) formulation calculates the transmissivity of an aquifer by matching a plot of relative head (linear scale) versus time (logarithmic scale) to one of a set of type curves. The method assumes that the change in head after a known volume of water is injected or removed is instantaneous and that the (non-flowing) well is screened over the entire thickness of an artesian aquifer. It is directly applicable to fully penetrating screened wells in confined aquifers, but may be used to determine the transmissivity of the portion of an aquifer over which a partially penetrating well is screened, assuming no vertical flow occurs.

The Hvorslev method (1951) is based on a solution of the LaPlace equation and does not account for aquifer storage. A straight line is drawn through a semi-log plot of relative head versus time. The time that would be required for complete equalization of head difference if the original rate of inflow were maintained (defined as the basic time lag, T_0 , and equal to the time when $H-h/H-H_0 = 0.37$) is used to calculate the hydraulic conductivity. The value of T_0 is measured graphically, and the ratio of the piezometer length to radius is assumed to be greater than eight ($L/R > 8$).

REFERENCES

Bouwer, H. and Rice, R.C., 1976. "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells", Water Resources Research, Vol. 12, No. 3, pp. 423-428.

Cooper, H.H., Bredehoeft, J.D. and Papadopoulos, I.S., 1967. "Response of a Finite-Diameter Well to an Instantaneous Charge of Water", Water Resources Research, Vol. 3, No. 1, pp. 263-269.

Hvorslev, M.J., 1951. "Time Lag and Soil Permeability in Groundwater Observations", U.S. Army Corps of Engineers Waterways Exp. Sta. Bull. 36, Vicksburg, MA.

NAVFAC, DM-7, 1971. Design Manual - "Soil Mechanics, Foundations and Earth Structures", Department of the Navy, Naval Facilities Engineering Command.

[jam-13-6]

APPENDIX 0

CALIBRATION AND MAINTENANCE OF HCN MONITOX DETECTOR

Bedienungsanleitung
Operating Instructions

COMPUR 4100 SD
Monitox HCN

MDA Scientific, Inc.
405 Barclay Blvd.
Lincolnshire, Illinois 60069
Phone: 800-323-2000 (in IL 312/634-2800)
Telex: 72-6399 MDA-USA • Fax: 312-634-1371

Compur-Electronic GmbH

5.6.

Hinweise zur Fehlersuche

Fehler	Hinweis
Batterietest Detektor geht nicht	Batterien wechseln (5.1.)
Funktionstest mit Generator geht nicht	a) Evtl. mit 2. Detektor nachprüfen, ob Generator o. k., sonst b) b) Filterkappe wechseln (5.2.), wenn nicht verschmutzt, c) c) neue Sensorzelle einbauen (5.3.).
Generator liefert nicht genug Gas	Zelle befeuchten, d. h. mit Feuchthaltekappe mehrere Tage stehen lassen, sonst Generatorzelle wechseln (5.4.).
Am Generator leuchtet rote LED beim Test auf	Generatorbatterie ersetzen (5.5.).

6.

Zubehör und Verbrauchsmaterial

Bestellnummern für Verkaufseinheiten

1. Gasdetektor HCN Digitalanzeige, 2 Alarmschwellen mit Dosimeter-Anschluß	U 5306 203
2. Zelle HCN mit Filterkappe	U 5800 103
3. Filterkappe HCN (10 Stück)	U 5810 341
4. Batterie PX 23 (1 Stück)	U 4990 001
5. Gasgenerator HCN	U 5390 300
6. Generatorzelle HCN	U 5820 300
7. Kalibriergasadapter	U 5900 106
8. Meßleitung: Eichen	U 5900 112
9. Digitalvoltmeter	U 5900 018
10. Stromgenerator	U 5900 023
11. Kalibrierkabelsatz für Stromgenerator	U 5900 125
12. Protokollheft	U 5900 004
13. Ohrhörer	U 5900 002

Table of Contents

	Page		Page
Important Information	20	5. Maintenance and Servicing Instructions	30
1. Technical Description of the COMPUR 4100 SD Monitor		5.1. Battery Replacement	30
Detector for HCN	21	5.2. Filter Cap Replacement	30
1.1. Applications	21	5.3. Sensor Cell Replacement	30
1.2. Mode of Operation	21	5.4. Generator Cell Replacement	30
1.3. Technical Data	22	5.5. Generator Battery Replacement	31
1.4. Cross-sensitivities	23	5.6. Troubleshooting	31
2. Technical Description of the COMPUR 4100 Monitox		6. Accessories and Consumables	31
Gas Generator for HCN	23	Attachment	32
2.1. Applications	23		
2.2. Mode of Operation	24		
2.3. Technical Data	24		
3. Use of the detector and generator	25		
3.1. Detector Actuation and Functional test	25		
3.2. Use of the Gas Detector	26		
3.3. Connecting the Earphone	26		
3.4. Connecting the Dosimeter	26		
3.5. Digital Display	27		
3.6. Detector Deactivation and Storage	27		
4. Calibration Instruction for the Detector	28		
4.1. Accessories required	28		
4.1.1. Calibration with gas	28		
4.1.2. Calibration - Electronic Method	28		
4.2. Zero calibration and gain adjustment with calibration gas	28		
4.2.1. Preparation	28		
4.2.2. Zero-Adjustment	28		
4.2.3. Gain Adjustment with gas	29		
4.2.4. Gain Adjustment with the current calibrator	29		
4.3. Setting the Alarm Thresholds	29		
4.4. Concluding the adjustment operations	29		

Gas Detection and Warning System COMPUR 4100 SD Monitox HCN

The COMPUR 4100 SD Monitox Gas Detection and Warning System comprises

- 1 gas detector (alarm unit with digital display)
- 2 gas generator (test unit)
- 3 console (recommended accessory)
- 4 detector log (recommended accessory)

The system is especially designed to monitor the TLV of HCN.

CAUTION!

Although the 4100 SD Monitox for HCN has been highly simplified for ease of operation by the user, it is nevertheless a complex measuring instrument which will operate reliably only if these operating instructions are carefully observed and if the instrument is checked regularly by the safety officer.

This applies in particular to the regular replacement of the cells and daily functional tests. The responsibility for any changes made in the alarm threshold settings must be borne entirely by the operator; COMPUR recommends the strict observance of the TLV. Since the unit is designed to be intrinsically safe, all repairs must be made by the manufacturer or other approved personnel.

COMPUR offers the instrument with the following factory settings:

- first alarm threshold = at TLV = 10 ppm
- second alarm threshold = at 2 TLV = 20 ppm

The detector cell will be destroyed if the detector is permanently exposed to a HCN-concentration exceeding 1000 ppm. In this case the cell has to be replaced.

1.

Technical Description of the COMPUR 4100 SD Monitox Detector for HCN

1.1.

Applications

The COMPUR 4100 SD Monitox is a personal monitor for HCN.

It is designed to be worn attached to the clothing near the breathing zone of the person to be protected. The detector produces an audible first alarm when the HCN-concentration exceeds the TLV (factory setting: 10 ppm) and a second alarm, when it exceeds 2 x TLV.

Independent of the alarm setting, the digital display shows the actual HCN-concentration in ppm (parts per million) in the nominal range of 0 - 100 ppm HCN.

In conjunction with the COMPUR 4102 Dosimeter, the unit can be employed to register HCN-concentrations at confined spaces ranging from 0 to 10 x TLV.

The COMPUR 4100 SD Monitox cannot be used to measure process gas streams or in presence of continuous high HCN-concentrations.

1.2.

Mode of Operation

Ambient air diffuses through the filter insert (a dust filter) (5) to the measuring cell. The measuring cell, a dual-electrode electrochemical cell with an organic electrolyte gel, generates an output current proportional to the partial pressure of HCN in the air.

A series of electronic amplifiers supply a voltage signal which is fed to the comparator for the alarm threshold. If the first alarm threshold is exceeded, an intermittent tone is produced; if the second alarm threshold has been exceeded a dual-tone signal is produced by the tone generator and loudspeaker (or earphone in very loud areas). The standardised analog signal corresponding to the actual HCN-concentrations (the TLV corresponds to 80 mV) can be fed to the Dosimeter.

The same signal is fed to the AD-converter driving the digital display. The display is adjusted to give a reading of 10 ppm at 80 mV input.

The 4100 SD Monitox consists of two separate power circuits (via two miniature batteries); the circuit for the analogue part is separated from that for the alarm-generation.

When the „on-off“ switch is moved to the „Batt.“ position, the batteries will be tested before the instrument is turned on. In this switch position, the batteries are electronically tested under the high load of the final tone stages. If one of the batteries fails to reach the predetermined lower theoretical limit, no alarm will be heard.

1.3.

Technical Data for the COMPUR 4100 SD Monitox for HCN

Conformity certificate	BVS 82.013
Safety class	EEEx Ib II CT 6
Dimensions	104,4 x 82 x 24 mm
Weight (with batteries)	approx. 150 g
Power supply	2 x PX 23 (5,6 V)
Battery service life	approx. 1000 h.
Display range	0 - 100 ppm
Alarm volume	min. 80 dBA / 30 cm
Alarm levels	2 alarms, adjustable
Response time	$T_{90} < 10$ s $T_{95} < 3$ min.
Time to alarm	20 ppm < 15 s 50 ppm < 3 s
Connection possibilities	earphone, dosimeter
Temperature range	0 - 50 °C
Relative humidity	10% - 95%
Zero point drift	< 1 ppm / 6 months
Sensitivity drift	< 15 % / 6 months
Service life of the cell	min. 6 months (dependant on dose)

1.4.

Cross-sensitivities

Test components	Test concentration	Indication in ppm HCN
SO ₂	5000 ppm / 40% rH	10
NO ₂	10 ppm	- 6
NH ₃	1000 ppm	10
CO	1000 ppm	—
CO ₂	1000 ppm	—
H ₂	1000 ppm	—
CH ₃ :CHCN	10 ppm	—
CH ₃ CN	200 ppm	—
(CH ₃) ₂ N	500 ppm	17
CH ₃ OH	200 ppm	—
COCl ₂	5 ppm	10
Cl ₂	10 ppm	5
HCl	10 ppm	7
H ₂ S	2 ppm	10
Hydrocarbons, saturated	2% vol.	—
Hydrocarbons, unsaturated	1% vol.	—
Aromatic compounds (also alkylated)	200 ppm	—

2.

Technical Description of the COMPUR 4100 SD Monitox Gas Generator for HCN

2.1.

Applications

The HCN gas generator serves to enhance the reliability of the Monitox gas detection and warning system. The Monitox detector must undergo a functional test by placing it on the generator before each use. The generation of a gas concentration exceeding the TLV ensures that the detector will respond reliably during use (picture 2).

The gas generator, however, is not designed to generate a calibration gas of known concentration. Daily testing of the Monitox detector does not mean that the user is not recommended to change cell sequentially.

The COMPUR 4100 Gas Generator must not be exposed to or used in explosive atmospheres.

N.B.: The generator cell may dry out at very low relative humidity in the air. In this case, it is necessary to put the moisture cap delivered with the generator on top of the generator always when it is not in use.

This ensures a correct gas concentration for the detector test.

2.2.

Mode of Operation

The switch on the generator is activated by placing the detector in the matching recess on the generator head.

A small fan feeds a flow of air past the generator cell directly to the detector cell. At the same time, gas is generated electrolytically in the generator cell in such an amount that the gas concentration is high enough to cause the detector to respond within 10 seconds (alarm threshold 10 ppm). The period of gas generation is indicated by the green LED.

The red LED indicates when the battery must be replaced.

After a 10 seconds interval, gas production is terminated and the fan conveys pure air until the detector is removed.

This functional test of the detector checks any of the following defects:

- clogging of the dust filter
- a malfunctioning cell
- a malfunctioning electronics system
- a malfunctioning generator.

2.3.

Technical Data of the COMPUR 4100 SD Monitox Gas Generator for HCN

Dimensions	133 x 65 x 40 mm
Weight (incl. batteries)	approx. 250 g
Temperature range	0 °C – 50 °C
Power supply	9 volt alkali battery, leakproof, e.g. Mallory 1604
Generator cell service life	approx. 3000 tests or for 1 year
Battery service life	approx. 3000 tests

3.

Use of the detector and generator

3.1.

Detector actuation and functional test

Battery Test

Turn the switch on the COMPUR 4100 SD Monitox to "Batt.". If the battery has sufficient power to operate the detector for eight hours, an audible (intermittent) tone will be heard. The LCD-display is switched off at the "Batt." test position. If no tone is emitted, this indicates that at least one of the batteries is exhausted. For safety reasons both batteries should be replaced (refer to section 5.1.).

When the audible tone has been heard (to preserve batteries, the test should be as short as possible), the switch is moved to "ON". The tone will cease. The LCD-display is operating now. It must show "0" ppm after some seconds.

Functional Test (picture 2)

Place the detector on top of the generator as illustrated.

As soon as the detector sounds its alarm, it must be removed from the generator. The detector is ready for operation once the alarm has ceased.

If the detector alarm does not sound within ten seconds the detector has to be checked and serviced. If necessary, the filter cap has to be replaced (see point 5.2.).

It is advisable to record the test and assignment of the gas detector in the detectolog.

The battery test and functional test must be performed prior to each use to thus ensure maximum safety.

During the gas test the LCD-display must show the response of the cell to HCN-concentration as well. As the alarm threshold is factoryset at 10 ppm the alarm should sound at 10 ppm. As the display reads a new value every second, the time for alarm and display of 10 ppm may be different.

3.2.

Use of the Gas Detector

The gas detector must be worn in the breathing zone of the person to be protected and the filter cap (5) should not be covered in any way.

The rubber lip on the carrying clip makes it possible to securely attach the Monitox to folds of clothing (e.g. the breast pocket).

Since this is not deemed adequately secure, the alarm supplied with the Monitox can be secured in the holes of the carrying clip. This enables the Monitox to be worn around the neck.

Whenever possible, the filter cap should be protected from water, dust-laden air or dirt. With the battery and functional tests (refer to point 3.1.) should be performed before the detector is put into operation.

When HCN gas concentration in the vicinity of the sensor exceeds the set alarm value, the alarm will sound after a delay dependent on the gas concentration (The higher the concentration, the more quickly the COMPUR 4100 SD Monitox will respond).

The alarm sounds at a level of at least 80 dB at a distance of about 30 centimeters (12 inches).

3.3.

Connecting the Earphone

When the detector is being utilized in an area with high background noise, the optional earphone should be used to be sure that the alarm will not go unnoticed. The earphone is connected to the earphone socket (9) on the detector. This socket disconnects the internal loudspeaker. If the earphone is being used, it is important that the tests also be conducted with the earphone plugged into the detector (refer to point 3.1.). When the earphone is not being used, the socket should be closed with the plastic plug.

3.4.

Connecting the Dosimeter

The COMPUR 4102 Mini-Dosimeter can be connected to the 4100 SD (refer to operating instructions for the 4102).

The generator test can also be carried out with the Dosimeter connected to the COMPUR 4100 SD if the detector is turned 180° about its longitudinal axis relative to the position shown in point 3.1. and then placed on the generator in that way, that the cell fits into the recess on the generator. The functional test is then started by pushing the generator button with one's finger.

The plug should be replaced in the Dosimeter socket whenever the Dosimeter is not being used.

3.5.

Digital Display

In addition to the warning-function of the COMPUR 4100 SD Monitox its digital display (8) gives a direct reading of the actual HCN concentration.

Thus it is possible to determine HCN-concentrations below and above the TLV-level, giving the skilled worker and industrial hygienist the means to detect unusual conditions of HCN-concentrations with high accuracy and resolution.

The COMPUR 4100 SD Monitox is, however, even with its digital display, primarily a measuring and warning device for personal protection.

It has not been designed for measurement in process-control; moreover exposures to high HCN-concentrations for any length of time must be avoided, as the accuracy of the reading will suffer.

3.6.

Detector Deactivation and Storage

a) brief period of inactivity (up to a month) the detector is deactivated (switch to "OFF")

b) Prolonged inactivity and storage

It is advisable to open the Monitox and remove both the cell and batteries, to provide them from leaking and corroding the interior of the Monitox (refer to the sections on cell and battery replacement 5.3.).

Before reutilizing the Monitox a new cell has to be installed.

4.

Calibration Instruction for the detector COMPUR 4100 SD Monitox

To enhance the intrinsic accuracy of the detector for HCN it is necessary to calibrate the detector either with a HCN nitrogen mixture with definite concentration of HCN or make an electronic adjustment by means of the COMPUR current generator U 5900 023.

4.1.

Accessories required

1.1.1.

Calibration with gas

- a) calibration cap to place onto Monitox
- b) flow meter
- c) millivoltmeter 0 - 2000 mV; input resistance $\geq 1 \text{ M}\Omega$
- d) tubing, set of test cables, screw-driver
- e) calibration gas, known concentration, about 10 ppm HCN in pure N_2

Remark: The generation and above all the stability time of HCN calibration gas is not without problems. So if only a small number of detectors are to be calibrated, the electronic method should be preferred.

1.1.2.

Calibration - Electrical Method (picture 6 and 7)

- a) calibration unit (current generator)
- b) millivoltmeter 0 - 2000 mV, input resistance $\geq 1 \text{ M}\Omega$
- c) set of test cables, screw-driver

4.2.

Zero calibration and gain adjustment with calibration gas

4.2.1.

Preparation

The Monitox is opened and positioned with the electronic components upward on a non-slip surface. The cover with the digital display is carefully put aside with the display upward.

Then the unit is switched on via "Ball." position to "ON". The LCD-display should read 00 ppm after several seconds.

The excellent zero-point stability of the cells will normally make unnecessary to adjust the zero-point. Deviations from zero are caused mostly by faulty sensor cells.

For zero-checking remove sensor cell.

4.2.2.

Zero-Adjustment

Connect Millivoltmeter to tie down point (MP 2) and GND (MP 1) (picture 6). If the reading is not zero in clean air, and also is not zero without sensor cell, potentiometer (R 9) (offset voltage) has to be varied until the reading is zero.

Note: If reading is zero without cell and not zero with the cell, it may need up to one hour to stabilize the cell. If a cell has been removed for a longer period without short-circuiting the two connectors, the time to stabilize may be up to one day. A new cell therefore has short-circuit on the small pcb, that must be broken away before inserting the cell.

4.2.3.

Gain Adjustment with gas

The special calibration adapter is tightly put onto the dust filter on top of the detector cell.

Adjust a calibration-gas flow through the calibration cap; flow rate should be approx. 100 ccm per minute and the inlet must be the smaller pipe; to avoid pressure variations the outlet should be free of obstacles. After 5 minutes the display of the Monitox has reached its final value.

Connect millivoltmeter to tie down point (MP 2) and GND (MP 1). Depending on the concentration of the calibration gas the following voltage should be displayed: (adjust by means of pot R 7)

$$U = \frac{[c] \text{ in ppm}}{10 \text{ ppm}} \times 80 \text{ mV}$$

The display of the Monitox must show the gas concentration. In the opposite, adjust pot (R 15) until correct reading is shown.

4.2.4.

Gain-Adjustment with the current calibrator

Each detector cell produced by COMPUR is supplied with an indication of the output current at 10 ppm HCN. (Never throw away packings of replacement cells before having noted this indication!!!)

Remove detector cell. Insert calibration cable with the plug board into plug connector for detector cell. The gold contacts must touch the spring contacts. Connect other side of the cable to the current generator.

Make sure of correct polarity of plugs. Switch on generator, turn button till generator display shows output current of detector cell.

Remark: Display always shows actual value of current. If it is zero, check the contacts!

Connect voltmeter to tie down point (MP 2) and GND. Adjust sensibility by means of pot (R 7) until 80 mV is displayed. Monitox must now display 10 ppm. In opposite, adjust pot (R 15).

4.3.

Setting the Alarm thresholds

The alarms of the standard version are to be set on 10 ppm (first alarm 1 TLV) and 20 ppm (second alarm 2 x TLV).

To set the alarm levels, push the 2 mini-switches (S 1) to the right. The display of the Monitox shows now the level of the 1st. alarm threshold. This can be adjusted by means of the potentiometer (R 30).

To adjust the 2nd alarm level, push the upper switch to the left. The display shows now the 2nd alarm threshold. This can be adjusted by means of the potentiometer (R 29).

After having adjusted the alarm levels, push both mini switches to the left. The Monitox display shows now the actual concentration of HCN.

4.4.

Concluding the adjustment operations

After the settings have been made, turn the switch on the pcb to "OFF"-position. Make sure that the switch-handle on the cover is also in the "OFF"-position. Then carefully replace the cover and fold the connecting cable between pcb and display so that it is neither squeezed in nor cracked. Tighten the screws. The Monitox is now ready for operation.

5. Maintenance and Servicing Instructions

5.1. Battery Replacement

1. Turn switch (7) to "OFF".
2. Remove three screws (12).
3. Turn detector over and remove front cover.
Attention: Do not attempt to remove the cable between front panel and pcb!
4. Lift out battery housing, disconnect plug.
5. Unscrew and remove battery lids.
Replace batteries with +pole towards lid.
Replace lids.
6. Plug-in battery plug. Ensure cable and cable socket in right position.
7. Replace battery housing and front cover, carefully adjust the cable of the front panel, so that it is not damaged by fixing the front panel; then tighten the screws.
8. Repeat battery test.

5.2. Filter Cap Replacement

1. Remove screws (7) (picture 4) and open detector.
2. Carefully remove sensor cell together with filter cap (5). Pull cap off cell (4).
3. Attach new filter cap (with identical gas label HCN) and return sensor cell to original position.
Filter cap order number appears on plate attached to inside of front panel and is listed in section 6.
4. Replace front cover and tighten screws
5. Repeat performance test.

5.3. Sensor Cell Replacement

1. Open detector (see 5.1.).
2. Remove cell together with filter cap.
3. Remove new cell and filter cap from storage container, pull transparent cap off the cell and replace this by the new filter cap. Correct position of filter cap is shown in illustration.
Remove short-circuit protection attached to pcb by breaking it away.
4. Proceed current calibration (4.2.4.).
5. Replace sensor cell with filter cap in proper position.
6. Close Monitox.

5.4. Generator Cell Replacement (picture 5)

1. Open housing (as when replacing battery)
2. Unsolder fan leads (10).
3. Loosen four screws (11) and three screws (12).
4. Remove outlet, gas cell and fan through the front.
5. Carefully insert replacement unit U 5820 300 consisting of outlet, cell and fan and tighten screws (12).
6. Tighten screws (11). Align circuit board so that pin (13) reliably actuates switch (14) when gas detector attached.
7. Resolder fan leads (10).
8. Reassemble generator and tighten screws.
9. Testing: Use properly functioning gas detector for same gas. Switch to "ON", attach. Alarm must sound after about eight seconds.

5.5. Generator Battery Replacement

Loosen four screws on rear housing panel. Carefully remove front cover. For correct positioning of battery, refer to illustration 5.

5.6. Troubleshooting

Malfunction	Remedy
Battery test: no response	Replace batteries (5.1.)
Generator test: no response	a) Repeat test using 2nd detector, if no response, b) b) Replace filter cap (5.2.), if not dirty, c) c) Insert new sensor cell (5.3.)
Generator does not supply enough gas	Use moisturizing cap for several days, otherwise replace generator cell (5.4.).
Red LED lights up during test	Replace generator batteries (5.5.).

6. Accessories and consumables

Part Numbers

1. Gas detector digital display, 2 alarm thresholds with Dosimeter output	U 5306 203
2. HCN cell with filter cap	U 5800 103
3. HCN filter cap (10 pcs.)	U 5810 341
4. Battery PX 23 (1 pc.)	U 4990 001
5. HCN gas generator	U 5390 300
6. HCN generator cell	U 5820 300
7. Calibration gas adapter	U 5900 106
8. Measuring cable: calibration	U 5900 112
9. Digital Voltmeter	U 5900 018
10. Current calibrator	U 5900 023
11. Calibration cable used in connection with current calibrator	U 5900 125
12. Detectolog	U 5900 004
13. Earphone	U 5900 002



Engineers & Scientists
Environmental Services
Waste Management
Water Resources
Site Development
Special Structures
Geotechnical Analysis

MADISON One Science Court, P.O. Box 5385, Madison, WI 53705 • (608) 273-0440
MILWAUKEE 11270 West Park Place, Suite 400, Milwaukee, WI 53224 • (414) 359-2424
MINNEAPOLIS 715 Florida Avenue, Suite 209, Minneapolis, MN 55426 • (612) 593-5650
CHICAGO One Pierce Place, Suite 1110, Itasca, IL 60143-2681 • (312) 773-8484
DETROIT 26200 Town Center Drive, Suite 105, Novi, MI 48050 • (313) 344-0205